A REVIEW

OF

THE PEAT QUESTION;

ITS POSITION AND PROSPECTS,

IN FOUR PAPERS UPON PEAT:

WITH

SUGGESTIONS FOR THE PROMOTION AND EXTENSION OF TURF INDUSTRY.

BY

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PREFACE.

The fuel crisis through which we are passing, and which it is to be feared may, with more or less severity, henceforth become chronic amongst us, brings under consideration in every home in the land the question of the utilization of the peat resources which we so largely possess; but it will be admitted that up to the present time there has been too much hope of results from inventions and mechanism, and too little reliance upon what might be effected by an improved extension of the plain but useful industry which already exists in this country. The interval that has elapsed since the cost and scarcity of coal forced the peat subject into prominent notice has given time and opportunity for the investigation of the capabilities of mechanical systems, and the results are not favourable to any reasonable hopes of our soon arriving by their aid at any generally useful results. We can therefore afford now to look, if less hopefully, at least more soberly and usefully, at the position, and to ask ourselves what the proper course would be if this fuel crisis increased—if it became intensified—if from physical or social causes

the production of coal in these countries almost ceased for a time. Would we, under such circumstances, continue to look to rival peat systems, and the disputations of patentees, or would we actively organize into increased usefulness the existing working resources which we possess, of which we are assured, and upon them build up and develop an extended industry in good, plain, useful turf? The answer is obvious; and in the writer's opinion, it is *the only* answer by which our present circumstances should be met. From and with this widened and widening industry let improvements come—and be honours and rewards the meed of every useful improver—but let us not put our hopes in their possibility, to the neglect of an extension of the industry itself. It is hardly a discredit to the people of the Netherlands that they make the peat of their country practically their staple fuel, without either patents or peat machines; that they turn their wastes of bog into blessings and fields of plenty, and that by their perseverance and labour they offer to other nations the spectacle of a comfortable and contented people in a country, where, as has been well said, nature has given everything against them and nothing for them. Is it probable that if we toiled in the same ways of labour we would be more likely to find ourselves nearer to the utilization of our peat resources for generally useful purposes, than we shall be from the results of a few peat works capable, at best, of only a limited production of dense turf fuel?

From the inquiries in which he has taken part, as well as from other investigations of the subject, the writer arrives at the conclusion that it is mainly only by an improved extension of ordinary turf industry, but in part coupled with some preliminarily moderate mechanical efforts for the making of dense turf, that any generally useful results in peat can be at present, or for some time to come, worked out. But while under that conviction, and impressed with its reasonableness, he yet offers, for the independent consideration of his readers, particulars of every useful and practical mechanical effort of any value for the improved production of peat fuel, that has been made up to the present time ; that they may all be canvassed upon their own merits, and that the subject may be presented to the public as a full and fair technical review, in the interests as well of present utilities as of future possible improvements in peat fuel manufacture, without reference to the writer's own opinions or conclusions. For these he asks only a disinterested and impartial consideration.

18, Upper Gloucester-street,
Dublin, May, 1873.

TURF INDUSTRY.

THE object of the present paper is, to help to give some practical direction to the conviction now generally felt, that the time has come when something should be done to procure fuel from our bogs.

The impression on most minds at present is, that the difficulty lies in our want of some systems, at once effective and economical, for making improved fuel from peat; and because we have them not, hardly any other course is thought to be open to us for increasing our supplies of fuel. This conclusion is not only not altogether correct, but it is an embarrassing one, inasmuch as it withdraws attention and effort from the value and capabilities of ordinary turf.

Improved peat fuel manufacture simply means the conversion of fibrous peat into a condition in which it becomes dense, and this can be effected by any process that subjects the raw peat to a mixing or tearing operation, as, for instance, in some countries, where the usual course is to knead and tread the peat under foot.

Only those who have made trial for themselves, or who may be already familiar with it, can adequately realise the compactness and density which result, in the drying, from such a simple operation as that of tearing and mixing the raw peat; and upon another occasion I shall enter on the most effective arrangements for the purpose. As, however, for reasons which I shall subsequently give in this paper, the

production of dense turf by mechanical means cannot be realised *in quantity* for some time to come ;—as we cannot at all hope for such immediate results from it, as would largely come in aid of our supply of fuel, I purpose offering some remarks in reference to the production of ordinary turf.

The difficulties arising from the fibrous structure of peat are, as we have mentioned, capable of removal by the operation upon which the treatment of such peat depends for its conversion into dense turf.

According as peat deposits, however, become less fibrous, so does the necessity for the tearing up and mixing of the peat become also less requisite for producing dense turf.

In the cutting of almost all our Irish bogs, as the middle and lower portions are reached, we find peat, which, when properly cut and saved, makes excellent fuel—for instance, the dark-brown and dense black turf of almost every bog district.

These are portions that do not require any mechanical systems for their conversion into good turf fuel. From the comparative absence of fibre, the turf cut from them with the ordinary slane is, when dry, sufficiently dense for all general purposes. The position, then, is as follows.

Because the upper, or fibrous parts of our bogs require a mechanical treatment to convert them into dense fuel, we overlook the great capabilities that lie at once available a few feet lower down, and which do not need any mechanical systems for their conversion into good fuel.

It is most wise and proper to mature the best mechanical arrangements for making dense turf out of fibrous peat, but, at the same time, most unwise and improper to neglect the utilization of the large resources, in the shape of comparatively unfibrous peat, that are open to us at once, and which, instead of steam-engines and macerating mills, require only the strong arms and tough-handled slanes of good Irish turf-cutters, for yielding supplies of excellent fuel.

As a first step we must, however, make ordinary turf-cutting industry something worthy of the name. As it exists at present in this country, it is of the most uncertain and precarious kind. It is chiefly in the hands of persons who make it subordinate to the calls of farm work, and it has been allowed to remain in a low stage of rude labour, without improved implements, without shedding or storage, without means for convenient removal to canals or railways—in a word, without any of those mechanical aids that cheapen and improve production.

The result is, that although possessing resources of peat, at once ample and excellent, within short distances of Dublin and of several of our inland towns, with facilities for carriage both by rail and water, we, nevertheless, find ourselves unable to procure supplies of turf fuel to mitigate the scarcity and dearness of coal.

To the comparative cheapness of coal in past years, the neglected state of turf industry in this country is, no doubt, to be mainly ascribed; but, obviously, it is a state of things that should not be allowed any longer to exist. It is worth while to refer to the cost of production and value of ordinary turf.

The cutting, saving, and stacking of ordinary turf is generally done by contract where the quantity is considerable; and the rates paid of late years show that the labour cost averages about three shillings and sixpence per ton. If we include rent, superintendence, and contingencies, we may safely assume that the cost will be found not to exceed four shillings and sixpence per ton. To this, if we add a sum of five shillings for cost of carriage and of storing the turf for sale, as, for instance, in Dublin, and if we increase the amount by a sum of three shillings per ton for cost of management, and interest on capital, then, for twelve shillings and sixpence, one ton of good ordinary turf could be sold with a fair profit in the city of Dublin, or in any city or town to

which turf could be carried from the bog and stored at the rate of five shillings per ton.

We have proofs based on extended practical results, that in taking two tons of turf as equivalent in heating power to one ton of good coal, we are sure to be on the safe side of any estimate made with reference to the value of turf fuel. As long, therefore, as good coal shall cost, in Dublin, more than twenty-five shillings per ton, it would be advisable, for many purposes, to use turf, as there are *economic* considerations that make two tons of turf more than equivalent to one ton of coal. For instance, there is always more or less waste in coal, in the cinder, and unconsumed portions, while in turf all is consumed, and only the ash left behind. Again, a smaller fire may be made for occasional purposes with turf, than it would be practicable to make, cost for cost, with an equally small quantity of coal. It is a mistake, therefore, to continue to think that we cannot improve our condition in the matter of turf fuel, until we find ourselves producing improved fuel out of the fibrous portions of our bogs. If, years ago, the Dutch thought so, would we find them at present with turf as the staple fuel of their country ?

I can state, from my own personal investigations in Holland and the Netherlands, that the quantity of turf made by mechanical arrangements is the merest fraction in comparison with the production of ordinary turf. In only a few places were mechanical systems found to be in use there.

But it will be said, the Dutch have, in addition to ordinary turf, a kind of dense turf, made by kneading and mixing with the feet, which we have not. This is quite true ; but the dense turf so made is more in request and use for industrial purposes than it is for domestic uses. We shall do well to bear in mind the differences as to fuel that exist in the requirements for factories and for private houses. If it were necessary to assume, which it is not, that we cannot as yet produce

dense turf for industrial works, surely that would not be any reason why we should not apply ourselves to the production of ordinary turf for use in our houses.

The making of dense turf in the Netherlands proceeds not so much from choice as from necessity. The peat from which it is produced lies completely under water ; and as it is dredged up in a broken, shapeless condition, it is necessary to subject it to the kneading and treading process in order to make the whole into a uniform mass.

In this country, however, we have, in the lower portions of most of our bogs, black peat capable of yielding an equally dense fuel, without the disadvantage of lying submerged and covered by some feet of water. In almost all our bogs we have facilities for drainage, which are entirely wanting in those peat districts of Holland, in which the peat has to be dredged up from under water. To subject such black peat as is capable of being drained in Irish bogs, to any mixing or tearing process, would be simply a waste of time and money. We have, therefore, ample resources, at once available, for giving supplies of good turf fuel, if they be only properly developed.

This development, however, can be realised only by placing turf industry upon the footing of a special work, to be followed exclusively by those employed in it, without reference to anything else, for the longest periods, annually, during which it is capable of being carried on. This can be done only by undertakings of some importance, with capital for the payment of labour and the accumulation of stocks of turf during the working seasons, extending from March until August or September in each year.

We are sometimes told that our climate is not a favourable one ; but let it be remembered that for purposes of this industry we have not hitherto taken full advantage of our climate at the proper times and seasons. Would coal industry ever have attained its great results elsewhere if the shafts

were left unworked in the spring, in order that farm work might be done for the proprietors by the miners, and if in the summer the shafts were again closed, in order to employ the miners upon the sowing of green crops and the saving of the early hay crops? Yet exactly such, in principle, is the course that is every year pursued in Ireland by the persons who take on themselves to produce turf, and to some of whom we trust for our supply. It would be waste of time to follow up the results.

The industry, to be successful, must be followed as an industry. In the Netherlands those who pursue it follow it alone during the season. Frequently the work begins there in the summer months at 2 o'clock in the morning, and with short respites is continued until 5 o'clock in the evening. By this means the best portions of the day for the drying of the turf are turned to the best account. It is a mistake, also, to continue to think that average ordinary turf, such as we have referred to, is suited only for domestic uses.

In some parts of Germany ordinary turf is used as fuel for locomotive engines, without any modifications or alterations in their fire boxes. Let any who doubt it visit the railway works at Munich, and see the extent to which ordinary air-dried turf is used there for locomotive work. Looking at home, we have the testimony of the managers of the works of Sir A. Guinness in Dublin, that two tons of ordinary turf were found to be more useful and economical in the furnaces than one ton of coal—when coal rose as high as sixteen shillings per ton. As coal is now more than twenty-five shillings per ton in Dublin, we may infer, that if turf could now be had in quantity at twelve shillings and sixpence or thirteen shillings per ton, it would meet with a very large demand, not only in Dublin, but in any other city or town in Ireland, within distances from turf bogs varying from forty to sixty miles, with facilities for carriage by railway or canal.

Assuming a dearness of coal to await us in the coming winter, or any state of things that may henceforth keep coal from falling below twenty-five shillings per ton in Dublin or elsewhere in this country, it is submitted that we should at once address ourselves to the production of ordinary turf upon a large scale, with arrangements for its storage from the weather, both at the places of production, and in the vicinity of the railways or canals, where it would be kept for sale to the public.

By the production of large quantities, with adequate storage room, the improvement of the turf in drying and seasoning would be constantly on the increase.

Having thus sought to show how largely we can henceforth help ourselves, if we only bestow some efforts upon the production of good ordinary turf, I shall now make some observations upon dense turf manufacture.

With a view to utilizing the upper and more fibrous portions of our bogs, and for the conversion of such portions into a fuel peculiarly suited for industries, it is desirable that the making of dense turf should be undertaken and carried on, wherever practicable, at the same time with the making of ordinary turf. Still more, by means of shedding, the carrying on of this industry, if found a beneficial one, could be extended beyond the time when the ordinary turf work would cease for the year.

This dense turf manufacture is, however, felt upon all hands to be a new undertaking, and that, to be successful, it must take time for its establishment and extension. For these reasons it is impossible to hope for any important additions to our fuel supplies from it for some time to come.

Having taken some part in the origination and in the investigations upon the Continent, of the recent Peat Fuel Commission, I wish to see dense turf industry safely introduced and established in this country ; but as the result of the

best deliberations on my part on the subject, for some time past, I believe that it is not capable of successful development *on the great scale* at once in this country, and that our future prospects in turf fuel would not be likely to be permanently served by any attempts to effect large results from it at once. I believe in the value and importance of dense turf, and in the soundness of the principle of the tearing and mixing of fibrous peat for its production, but any efforts to make it a great industry *at once* would only run the risk of adding to the disappointments that have taken place already in the working of improved peat fuel.

I think that this industry will be best promoted by making it a portion, upon moderate scales at first, of the ordinary turf industries which I have advocated. In this manner it will supply the means of turning to account the upper portions of our bogs which need removal, in order that the less fibrous parts lower down may be reached for cutting in the ordinary way.

By combining it with ordinary turf cutting work, dense turf industry can thus be introduced without any serious risks, and its costs of production and commercial value can be fully tested, side by side with ordinary turf. Time and opportunity will also be given for maturing in practice the best arrangements, and for training persons to the special requirements of this kind of work.

The principle is of the simplest kind,—the tearing up or mixing of the raw peat, and nothing more,—but the difficulty is to do this effectively and economically upon a large scale; and as yet the capability of production in most of the mechanical arrangements for the purpose is found to be limited in proportion to the outlays necessary for machinery, and to the cost of the work, and the number of persons employed. This arises from the fact, that to obtain one ton of dense turf in the dry condition, from five to six tons of raw peat have to

be passed through any machine designed for the purpose. All such machines do certainly get through a great deal of actual work ; but as the net useful result in the shape of dry dense turf is only from one-fifth to one-sixth of the tonnage operated upon, the production is found to be comparatively small in proportion to the work done.

The capabilities of the machines for the purpose that were examined on the Continent varied from four and a half to fifteen tons of dry dense turf per day, at working costs averaging from six shillings to seven shillings per ton.

As an instance of the latest efforts, I may refer to the machine of Messrs. Clayton, Son, and Howlett, of London, of which a working trial was made in the month of February, 1873. Under the most favourable conditions its capability is stated to be equal to the maceration or tearing up and mixing of only seventy-five tons of raw peat per working day of ten hours. The result would be at best not more than fifteen tons of dry dense turf. In actual practice, however, the results would be more likely to be under than over fifteen tons—perhaps not much more than ten or twelve tons. The same quantity of black turf would be produced from the lower stratum of any of our Irish bogs by three or four good turf-cutters in one day, at a total outlay for labour of cutting of ten or twelve shillings.

I think it well to refer to this machine, as it represents the best and latest efforts of a very celebrated mechanical house, and I point to it to show, that although the principle of mixing the raw peat is the only sound one as yet known for the production of dense turf, yet it is impossible to resist the conviction, that its production *in large quantity* is not immediately practicable for general purposes, and that if we are at all to better our condition or to improve our position in the matter of fuel upon anything of an important scale, it can only be by recognising in ordinary turf the elements of legitimate

commercial enterprise, and by raising it from its present neglected and precarious state, as one of the rudest of labours, to the position of a creditable national industry, as we find it in countries so well known to history, commerce, industry, and the arts, as Holland and the Netherlands.

The investigations that have been recently made had for their object the ascertainment of the best modern systems in operation in other countries for making improved fuel from peat; and the principle of tearing and mixing the raw peat has been established most conclusively as the only advantageous one for the purpose; but it will not be a benefit if these investigations in any manner tend to diminish an energetic and extended production of ordinary turf.

For the furnace, the locomotive, and the workshop, we can supplement such dense turf as may be made by machinery by supplies from our naturally dense black turf; but for general domestic purposes, ordinary cut turf must be long the staple fuel wherever it shall be found to be cheaper in use than coal.

All the material elements of success are with us, if we only add to them effort, energy, and enterprise.

The fact that we are without coal upon a nationally useful scale, and that in its place we have such vast supplies of peat in this country, should stimulate us to the conviction that, in the allotted order of things, the duty assigned to us is that of turning to account the supplies of native fuel so abundantly provided for our use.

If coal is not won from its depths without outlays and labours, gigantic in proportion to other industries, can we expect to win our fuel from the moor and bog without giving to it some industrial efforts and attention?

In the next paper I hope to add to the views now put forward, some details of the extent and results of the turf industry of the Netherlands.

TURF INDUSTRY.

No. II.

I HAVE drawn attention to the Netherlands as a country in which turf is extensively used for fuel, and I propose giving in this Paper some particulars in reference to its production in the Low Countries. Before doing so, however, we should know how far in past years the circumstances of the Netherlands and of Ireland, as to the supply and cost of coal, approached each other, and to what extent in this respect these countries will admit of comparison with one another.

The question is mainly one of the comparative value and cost of coal and of turf, and it is worth while to weigh the evidences, and see how the Dutch have decided it for themselves. The subject can hardly be presented more practically for consideration to any thinking minds than by placing before them, instead of mere suggestions or theories, the worked out results that have been realised elsewhere in turf, and which are capable of being at any time referred to and seen in practice upon a large scale.

Although, without any coal resources of their own, the Netherlands are, however, well situate for its importation, not only from the Northumberland and Durham coal districts in England, but from those of Belgium on their south, and from the Prussian provinces upon their east.

From any of the coal-shipping ports of the counties of Northumberland and Durham to Amsterdam or Rotterdam, the distance may be taken as less than from the same

ports to London. In round numbers it may be averaged as about 300 miles by sea, and for purposes of comparison, we may say that for the importation of coal into Holland, the ports of Newcastle-upon-Tyne, Sunderland, and Hartlepool, are as available, in point of distance and freights, as the ports of Cumberland and Lancashire for the south and south-west of Ireland. A dozen years ago the freight for coal by ship to any of the Dutch ports from Newcastle-upon-Tyne averaged about eight shillings and sixpence per ton, and at that time coal for export could be had plentifully and cheaply at prices ranging from nine to ten shillings per ton for best qualities, free on board at any of the coal-shipping harbours on the Northumberland and Durham coast. As a simple matter of fact, I may state that at the time referred to Newcastle coal could be frequently had more cheaply at Amsterdam or Rotterdam than at Dublin, Cork, or Limerick.

In addition to these facilities for the importation of coal from the greatest of all the English coal-fields, and the one of all others best circumstanced, as well from its position on the coast as from its railway communications and shipping arrangements, for the export of coal at cheap rates, the southern parts of Holland are within easy reach of the important coal-field of Belgium, and from this district a considerable portion of the coal supply of the Netherlands has also been obtained. To the foregoing are to be added the still greater capabilities for supply of German coal by water-carriage on the Rhine, from the Westphalian coal-field, and in particular from the district of the Ruhr. From the shipping points on the Rhine adjoining this latter coal-field, coal is now carried in barges to Rotterdam at about six shillings per ton, and it is worth remark, that amongst the latest suggestions that have been made for the supply of coal to London, is one for its importation from the mines of this Westphalian or Ruhr district, and calculations have been submitted to show that German

coal, borne along the Rhine, can be imported into London at less than thirty-five shillings per ton.

Some idea may be formed of the extent and capabilities of this Westphalian coal-field, coupled with its position near the Rhine, when it is mentioned that its area covers from three to four hundred square miles, with seams of coal of almost all qualities, and with a total quantity equal to fully one-half of the coal deposits of England. At Ruhrort and Duisburg on the Rhine, barges drawing from five to six feet of water can take in this coal for transport, and the distance by river carriage from thence to Rotterdam is less than 150 miles.

From the returns of the Board of Trade we find that the total quantity of coal exported from England to Holland and the Netherlands for the year 1871 was rather less than half a million tons (495,488 tons), of the total value of £226,281. These figures give, on the average, a tonnage price of about nine shillings and twopence per ton all round.

If we take the supplies of coal received from the Prussian provinces, and from the Belgian coal-field, to have been in a somewhat like proportion to the importation from England, then we may assume the total supply of coal to the Netherlands to be about one and a half million tons yearly. As a large portion of this quantity of coal is, however, employed for railways, steam navigation, gas-making, iron foundries, and other industries, we can infer that, at least for domestic purposes, the use of coal in the Netherlands, with a population of nearly four millions, bears at most only a moderate proportion to that of turf.

To the advantages thus possessed by the people of the Netherlands for the importation of coal, we have also to add the maritime character and trading habits of the Dutch, and their unrivalled systems of internal canal communications, and the consequent cheapness of carriage by water.

The advances that have taken place generally of late in

the price of coal and of freights have extended themselves to Holland as well as to other coal-importing countries, and the result is, that at present the price of coal at the Dutch ports may be taken as varying from thirty to thirty-four shillings per ton. In the Autumn of 1872, the price for best Newcastle coal, even when sold in small quantities by retail, was about thirty-five shillings per ton in the Hague. For a standard measure of coal called a "mud," of which twelve and a half go to an English ton, the price then charged in that city by retail dealers was one florin and sixty-five cents, or, in British money, two shillings and ninepence, equivalent to about thirty-four shillings and sixpence sterling per ton.

Having thus stated the case as regards the supply and cost of coal in Holland, I shall next offer for consideration the extent to which turf industry has, nevertheless, been developed there, and we can hardly suppose that, side by side with coal, it could have become the staple fuel of nearly three-fourths of the population, if there were not some economies or advantages in the use of their native fuel by the Dutch.

Upon this subject I shall offer some particulars from the latest work in which this industry has, with others, been reviewed by an accurate observer and graphic writer, Alphonse Esquiros, in his volumes "La Neerlande et La Vie Hollandaise," published at Paris in the year 1859. Of these volumes an excellent English translation was published by Messrs. Chapman and Hall, from the pen of Lascelles Wraxall, in 1861, from which I shall take the liberty of making the following abridged extracts upon this subject.

"In the Netherlands the extraction of peat supplies labour for thousands of arms. Nearly the whole population of Holland warms itself with turf; but how many live by it! The mode of warming is akin to the manners and domestic life of nations. The ancients thoroughly comprehended these relations, for they made the hearth the religious symbol of the

family, but it is before all, in the life of northern peoples, the the hearth plays a principal part. There man, obliged to produce light and heat, has placed in his daily task a spark of those feelings which render existence noble. How often have I stopped on the almost interminable plains of Drenthe and Over-Yssel to watch the thick white clouds which the peat fires sent skywards. These clay or turf roofs, thus draped, caused me to think of all the tranquil joys of nature, for the smoke that rises at eventide to heaven may be called the prayer of the house."

"Although peat does not give the cheerful flame of wood, nor the red light of coal; if it does not give the sparkling brilliancy or heat of other combustibles, it is not less a considerable resource in a country where nature has given everything, not for man, but against him. The consumption of peat is considerably increasing in the Netherlands, and its production there now amounts to some millions of tons annually. These figures are sufficient to prove the importance of the works connected with the peat-beds."

"These works are interesting from three different points of view:—The economist likes to follow the extraction of the peat, the preparation and industrial and domestic uses of the combustible, and the relation in which the peat-beds stand to agriculture. The geologist seeks the origin of the peat, the formation of this recent soil, and the monography of the strata on which the works of man repose. Lastly, the travelling moralist cannot refrain from noticing that this trade has given some singular traits to the population of the provinces in which the peat-beds are now found most abundantly, namely, Friesland, Drenthe, Groningen, and Over-Yssel."

"The extraction of peat varies with the nature of the beds, and we may form two great divisions according as they are high or low. As an instance of the working of the high peat-beds (*hooge veenen*), being those which are capable of natural

drainage, the neighbourhood of the town of Assen may be referred to. This is a new, quiet, and well lighted town, where the provincial authorities of Drenthe hold their sittings. An official world of employès and magistrates reside there; pretty houses stand detached here and there, while clumps of trees, gravelled walks, and patches of grass, connect by a belt of verdure the Town House, the Hall of Justice, and the Church. In the vicinity are delightful country villas, and by their side extend gardens or prairies, which a quarter of a century ago were peat-beds. A great number of these are still worked; they communicate by private canals with a central canal that connects Assen with Meppel, and on which the sails of the heavy barges carrying the peat are expanded. Situated in the midst of perfect steppes, on which grow heath and other wild plants, the high peat-beds—a name they owe to their higher position and relatively dry nature—constitute the principal, we might say the sole, wealth of this province, which cultivation has not yet enlivened."

The writer then describes the cutting of the turf and its air drying, in which there is not any difference from the systems usually practised in Ireland, and he next describes as follows, the mode of extracting the peat from the low peat-beds (*lage veenen*), or those in which the peat lies under water:—

"In South Holland, a few leagues from the Hague, is the village of Wateringen. Gardens, intersected by small canals, wooden bridges leading to paths covered with fine sand, fields artistically cultivated, houses, which fruit trees enfold like a garment, a school, two churches, and a mill with gilded axis, form what the English call a secluded spot. By the side of this village extend the peat-beds."

"The difference between the high and low beds is, that in the latter, as soon as the ground is opened, water is found. In former times, barren or nearly barren, lands were used for

the purpose; but at later periods, influenced by the gain arising from the peat trade, the inhabitants destroyed fertile plains and fields annually covered with abundant crops. Holland thus lost some of her territory daily, and at some points the excavations even weakened the dykes raised to defend the country against the sea. Holland then offered the spectacle of a people already enjoying a very limited territory, and yet incessantly working at its destruction. The finest fields man's eye had ever rested on disappeared, and the government of the country interfered to set limits to this devastation of the soil. Decrees were published at various periods, but their practical effect did not very much restrict the working of low peat-beds. It is necessary, however, to have the consent of the magistrates, and when that is obtained, the working is proceeded with as follows."

"The peat field is in the first place divided by the proprietor into several large strips, which will be worked in turn year by year. The strip which is selected for the first working, and which is generally situated at the extreme end of the field, is still covered with grass and plants; but this verdure soon disappears before the spades of the workmen: this is what is called 'beginning the trenching.' At Wateringen the peat is found under a stratum of earth and clay two or three feet in thickness. This arable land is carefully removed, and deposited in another part of the field: when the peat has been extracted, and the water drained off, it will become the basis of fresh cultivation."

"This preparation is generally made in winter, and the working of the bed of peat, which has been thus laid bare, ordinarily begins in April or May, and terminates about September. The peat is extracted from under the water, which lies immediately beneath the surface stratum of earth and clay, by a workman provided with long waterproof boots. He works more or less in the water, and fills the peat into a

barge. When sufficiently filled, the barge is moved to the land, and the peat is discharged into a wooden trough or vessel, about twelve feet square, and two feet deep. The mass is then trodden under foot by a workman, and any roots or pieces of timber met with are removed. When the peat has been sufficiently kneaded in this manner, it is thrown on the ground in lumps, and after four or five hours' exposure there, it is levelled by a workman with small boards fastened under his feet. The ground that receives the peat is, in the first instance, made level for the purpose, and it is generally strewn over with dry reeds or the like, to prevent the adhesion of the peat to the surface. After being made into a uniform stratum, by treading under foot, the peat is again left to dry a little, and it is marked out lengthways and crossways by an instrument like a rake, with lines for cutting, and it is subsequently divided into pieces according to the lines traced upon it by the peat rake. The drying is all done in the open air by women and children, and during the busy season about one hundred and forty workmen are employed on one bed at Wateringen. They are paid by piece work, and the cleverer of them earned about two shillings and sixpence per day."

"When, after having been several times turned over, the turf has attained sufficient dryness, it is formed into large square or round heaps, which are covered with reeds, hay, or straw, to defend them from the rain and frost. The turf is also placed in sheds, and so arranged that the wind can circulate freely through it. The turf does not leave these sheds until it is transferred to the long barges that carry it to market."

The tracts of water that are left after the extraction of the peat from the low beds are not, however, allowed to remain as useless wastes. In some instances they are stocked with fish, which supply food for many families, and create a new source

of productiveness. Generally, however, the waters are drained away by windmills, and desolate districts become thus converted into land of prodigious fertility. From the same author we extract the following particulars of the transport and sale of the turf, and of the results that have followed from the working of the peat-beds, and the subsequent reclamation of the land after the cutting away of the peat :—

"We have seen the peat extracted and prepared in the high and low beds, and we have now to follow it to market. The waters of the Waal, Leck, and Meuse, are perpetually furrowed by long boats, which transport the turf. Other boats of larger size, built in the provinces adjoining the peat-beds, navigate the canals of Friesland, Groningen, and Over-Yssel, and several of them cross the Zuyderzee. The boatmen usually live all the year round with their families in these wooden houses, and transport their affections, manners, and domestic hearth, from one place to another. On reaching its destination, turf porters assist in the unloading, and this class of persons constitute in themselves a corporation, with a commissioner, regulations, and privileges, in the different towns. In public ceremonies, and at great national festivities, the turf porters get up masquerading processions of their own, which are not without character."

"The quality of the turf varies a good deal; some more or less rich in woody matter, porous, compact, heavy, or light. These varieties correspond with the different industrial and domestic wants. Dutch housekeepers recognise at once, by the colour and shape, the properties of this fuel. There is a species suitable for the kitchen, another for the drawing-room, and a third for parlours. For industrial purposes the turf extracted from the low beds, as described, is preferred to that of the high peat-beds. Bakers bake their bread with loose sods that easily take fire, and amongst other uses we may mention that turf is employed for limekilns, breweries,

distilleries, oil mills, and tileries. From Zwolle to Arnheim we counted seventy brick kilns, which turn out bricks by millions, with turf as their only fuel. The consumption of turf in the factories has greatly increased in the Netherlands. During the eighteen years preceding the year 1859, the use of peat in factories had increased by much more than one million tons. The consumption of coal in the same period had increased by about one hundred and twenty thousand tons, whence it results that the progress in turf industry has been several times greater than that of the importation of coal."

"Coal evolves twice the heat of turf, but if two bushels of turf produce the same effect in a stove as one of coal, the turf costs, all proportions being maintained, much less than the coal. There is, consequently, a saving by the use of turf in Holland. Moreover, in addition to this economic consideration, we discover in the use of turf a question of great political importance for the Netherlands. By the employment of coal or coke, the manufactories, railways, navigation, and drainage of the Netherlands become dependent on the foreigner. Turf, on the other hand, is an important element of their national independence."

"The provinces that owe most to the existence of peat-beds are Friesland, Groningen, Drenthe, and Over-Yssel."

"Friesland derives its main wealth from cattle and peat-beds; and with almost its entire soil, consisting of clay, sand, and peat, it supports 200,000 inhabitants, in whom, as a race, a masculine and generous love of liberty is associated with a respect for plighted faith, sure probity, a positive mind, and an inflexible will."

"The manners of Friesland extend with some modifications as far as Groningen; and as an instance of the way in which the working of peat-beds has transformed an original wild soil, we shall refer to two old colonies, Hoogezand and Sappemeer."

"These once desolate marshy districts were disposed of in lots to colonists, and canals were formed by which the waters were drained into the adjoining streams of the province, and in 1628 the first boat laden with turf passed along the canal, and a few days later, the first cart conveying the same fuel rolled along the road made by the side of the water. At the beginning, poor cottages were built in these barren fields, and soon the extraction of the peat commenced on a large scale. Peat incessantly diffused more and more wealth through this remote country of the United Provinces, and handsome country-houses took the place of cabins and marshes. Each peat-bed, so soon as exhausted, was converted into arable land, which was first covered with oats, rye, and buckwheat, and eventually with potatoes. The buildings and clearings continually progressed, though not without meeting obstacles; and the works were several times suspended. But after each enforced repose the colonists said, with thorough Batavian coolness, 'we will begin again,' and they continued to restore life to this uncultivated soil. We have a right to feel surprised at the success of this undertaking, at a period when money was rare, and man had not at his disposal those machines he now possesses to multiply his strength."

"Two great qualities distinguished these colonists, constancy and devotion. When we see after two centuries what they achieve, when we are witnesses of the consequences of their victory, and calculate the amount of obstacles they had to overcome, we experience a feeling of thoughtful admiration for these ancestors of the soil. A flourishing population, a continued circulation of boats and wagons, a wealth elsewhere unknown of buildings and pleasure-houses, which rise at a spot where there were once only stagnant waters and a desolate heath,—all this forms a monument erected to the glory of human perseverance."

"The transport of the turf gave rise to an important navigation; and that again to ship-building. At first, small boats were employed, which increased according as the navigation extended. The colonies of Groningen now possess docks, in which valuable vessels are built, which sail to the principal maritime cities of Europe, and notably to St. Petersburg; though they even venture to the Levant and are beginning to visit America. One is really surprised to see all this naval prosperity spring up in the midst of an old heath. It is not so much the geographical position that contributed to this taste for ship-building inland, as that the enterprising spirit which animates the entire population has made up for the absence of the sea. Even if larger vessels are not built at these docks, situated inland, far up the country, it is not because either industry or money is deficient, but because there is no canal sufficiently large to receive ships of considerable tonnage for their convenient removal to the sea."

"From the province of Groningen to that of Drenthe, a few hours make a great change, and the traveller soon comes across almost interminable plains covered with heath, but between which rise clearings upon a considerable scale, with green plains and villages. It is difficult to imagine the wealth of the Drenthe peat-beds, but canalisation is the basis of this branch of industry, and as canals have not been made as yet here, the high peat-beds in a great part of this district now represent only a sleeping capital. Still we went in a barge from Assen to Meppel, along a canal which has already spread life over these silent plains."

"Drenthe is confounded with Over-Yssel, at any rate in the outskirts, in the matter of manners, heath, and peat. I will restrict to the colonies of the Dedemsvaart canal the history of the peat-beds of the last named province, and as an instance we may select the rising colony of Avereest. At Hoogezand and Sappemeer we have seen old colonies created

by men of the seventeenth century, but in Avereest we have the work of men of our own day. A few years back the only tree that formerly grew on this old heath was pointed out; it was, I think, a birch. Now, rich plains with clumps of verdure, orchards, and new plantations spring up as if by enchantment. On all sides fields are formed. The vital action of all this agricultural prosperity is the Dedemsvaart canal: into it a number of smaller canals leading to the peat-beds debouch in proportion as the clearings are effected. The water vivifies everything in its passage along the banks, prairies emerge from the old heath, flocks spring into life, and houses arise."

"We visited a farm having seven hundred and fifty acres of cultivated land, on which were ninety cows and forty pigs. The stables, cow-houses, and instruments of labour, all displayed true rustic opulence. When we reflect that this wealth dates from yesterday, we recognise, with a feeling of sympathy, what human industry is capable of effecting. Twenty to twenty-five years back, only goats were to be seen in the colony, but now farms and houses succeed each other, possessing an air of cleanliness and elegance. The first colonists dwelt in holes dug in the ground; these were followed by cabins, and these again by neat brick houses, and now all around we find an ever-growing, industrious, well-lodged and well-clothed population. In Holland, moral development is ever associated with that of material comfort, and in the colony now described there are four public schools. Such an association of facts, as land being reclaimed, and youth educated, is pleasant to look upon. There is no greater or more moral spectacle, than that of man extending by labour the domain nature has given him. When we now reflect that *it is peat which has done all this*, we ask ourselves why numbers of the inhabitants of the old world rush to remote districts in America, instead of coming to transform the plains of

Drenthe or Over-Yssel. The first colonists who arrived to work this great California, on the banks of the Dedemsvaart, were foreigners: there were among them Germans, Poles, and Greeks, but land exercises a power of rapid assimilation over different nationalities, and Avereest at the present day is to all intents and purposes a Dutch colony."

The author to whom we are so largely indebted for the foregoing particulars concludes his review of the subject as follows:—

"The working of the peat-beds in the Netherlands, regarded as a principle of industrial and agricultural wealth, has created entire provinces; it has supplied, and still supplies, employment for the needy classes, and it has transformed houseless wanderers into owners of the soil. We thus see what the Netherlands owe to peat."

To the foregoing we shall add a few observations by a recent German writer, who made the reclamation of the peat tracts of Holland a subject of special examination. In his Report upon the systems of working turf in Europe, published at Berlin in 1861, Dr. Dullo writes as follows in reference to the provinces of Groningen and Drenthe:—

"Travelling these two provinces, one sees everywhere, at each side of pleasant roadways, well cultivated fields, luxuriant meadows, and good-conditioned cattle. Proceeding further we come upon long villages lying beside canals,—villages which, in a high degree, bespeak comfortable circumstances, which reflect a well-to-do state of things, not dating from yesterday, but one that tells us, with unmistakeable force, that here wealth springs from the hands of men who toil laboriously and long, and who know how to maintain it. We pass through villages such as one nowhere else sees in all Europe,—villages in which order and politeness, cleanliness and happiness, the inseparable attendants of genuine comfort, are found, and in which we not unfrequently see the tasteful gardens before the

fronts of the houses, continued also to the rere, where the cattle stalls are built."

"The systematic reclamation of the peat-beds, carried out with rare zeal and perseverance by the Netherlanders, dates back for about one hundred and eighty years. About that time it was resolved that they should use their native turf fuel upon the most extensive scale. As a direct means to attain that result, colonisation was employed for locating in these great and far extending wastes of peat bogs and of moors the necessary human labour for the task, and then were opened out numerous canals in communication with the great water highways of the country. As an indirect means to the same end, a duty was at a later period laid upon foreign coal, and as Holland was without timber, turf became the common fuel of the country. The first efforts were successful; colonisation extended; colony after colony grew up, and most numerous of all were those where the peat-beds lay. In the province of Groningen, and partly in that of Drenthe, the oldest colonies have become the richest village districts of Holland. Long since the peat-beds there have disappeared, but behind them they left a new and an abiding wealth. It was part of the original design, not only to utilise the turf for fuel, but by the reclamation of the land to increase the productive powers of the country. All the villages in Groningen and Drenthe still bear the character of moorland colonies; it is found in the style of their plan and of their building, and to have seen one such village is to have seen all. By means of the canal communications, boats convey turf, not only to all parts of Holland, but beyond it; and they bring back the rubbish of buildings, sweepings of streets, manure, leavings and scrapings, and shreds of all kinds,—for all these things in the large and small towns of Holland are carefully collected, and are sold to the colonists of the bogs for filling up places from which the turf has been raised. Of actual earth or soil very

little is brought by the boats, as in Holland there is none to spare for the purpose. Generally within two years after the turf has been cut away, the place which it occupied is transformed into arable land."

"The contracts that are entered into with the colonists by the proprietors of the moors, whether the latter be the Government, or private individuals, are various. Sometimes the several portions of the moor or bog are sold, so that both the turf and the ground under it belong to the purchasers: frequently the colonists buy the turf only, and give up the ground to the proprietor when the turf is cut away; or again, the colonist binds himself to cut yearly a fixed quantity of turf, on which an average price is fixed, and of this the colonist pays a portion to the proprietor, and retains the remainder for his own labour. If in the sale of the turf the colonist makes more than the average price agreed on, the gain is his own."

"These entire provinces have never shared in the commerce which enriched Amsterdam and Antwerp. Their source of wealth lies in the wise administration of the State, and in the persevering industry and fixity of purpose of the people, whose frugality and economy have been in no way lessened by the freedom of their land laws, whose assiduity and love of labour are not diminished by the increase of prosperity, and the simplicity of whose habits and manners remains unreached and unaltered by luxury."

Like the Netherlands, Ireland also had tracts, and great ones too, of bog and moor, waste and unproductive, one hundred and eighty years ago,—but, unlike the Holland of to-day, Ireland has nearly the one-seventh of her surface waste and unproductive still.

Looking to the results that have followed from the colonisation of the bog districts in the northern provinces of the Netherlands, one can hardly pass from this part of the subject

without feeling what a work of great public usefulness will be done, when a wise administration shall some day remove the obstacles that at present stand in the way of the utilisation and reclamation, upon a large and nationally useful scale, of the bogs and waste lands of Ireland, by the purchase of them on fair and equitable terms from their present owners, and then allotting them upon suitable tenures to colonists. Before the efforts of the latter, scarcity of fuel in Ireland would soon become lessened; small industries would be multiplied in the production of turf for sale wherever it could find a market, and every year would see an increase made to the area of the productive soil of the country. The statesman that shall effect this work of utility for Ireland will live with honour in her social history, when names and dates of many monuments shall be forgotten.

With such facts as those before us—with the country which has realised them easy of access for their verification if necessary, may we not fairly claim for ordinary turf industry a more important value than has been hitherto allotted to it in Ireland?

During the period in which the use of turf so largely increased in the Netherlands, the price of coal did not average more than twenty-five shillings per ton at any of the Dutch ports. As in all our Irish ports, the average price of coal may now be taken, upon the lowest calculation, to be from thirty to thirty-five shillings per ton, have we not with us every reason why we should henceforth look to our native ordinary cut turf for a large portion of our future fuel?

The example of the Dutch is reassuring to us in more ways than one. It not only solves the economic question in favour of turf, when the cost of coal amounts to twenty-five shillings per ton at seaport towns, but it further demonstrates that its development upon a nationally great scale is wholly independent of mechanical systems. Its production may be

described as requiring only ordinary labour, continuously and effectively employed during the months most favourable for the cutting and drying of turf.

In offering the subject for consideration in connexion with what may now be called the fuel crisis of this country, I address myself to it with a view to the working out of large results for general purposes, at the earliest possible time; and it is in vain to hope for them, or for anything approaching to them, from any other source at present than from the extension of ordinary turf industry. For special uses, moderate workings for the making of dense turf should be carried on, as advocated by me in the last paper, and upon their results that industry and the extension of dense turf manufacture would depend. If reasonably successful, we cannot doubt that the making of dense turf will thus become established in the safest manner for its future development; and it is because I believe in its suitability for the conversion of the more fibrous portions of our bogs into fuel specially useful for industries, that I advocate its introduction at first in the manner, as I think, the best calculated of all others to lead to permanent results, by making it in the first instance a portion, upon a moderate scale, of ordinary turf industry.

It is, however, *to the latter alone* that we must look for such increased supplies of fuel, on a large scale, as can be now hoped for from our Irish bogs; and at the risk of being tedious, I ask all who entertain the subject thoughtfully, to keep before them the position, circumstances, and value of this plain and useful industry in the Netherlands. But for these increased supplies of turf we shall look in vain, if efforts be not now made calculated to lead to their production.

In another paper I shall refer to the investigations that were undertaken with respect to the making of dense turf by mechanical means, and shall take that opportunity to discuss the comparative efficiency of the different arrangements for

the purpose,—but entirely subordinate to the more urgent claims of our at once extending the production of ordinary turf, in a manner and upon a scale capable of henceforth giving important results, in point of quantity, for domestic and other purposes in this country.

The preliminary results of mechanical systems, while necessary for future guidance, are, however, not compatible with the commercial production from them at the same time, of large quantities of useful turf fuel, at the earliest possible periods in this country. From that stand-point the subject must be viewed, and I would confidently say,—from that stand-point alone, if it is to be viewed with reference to public utility,—and our duty now is, to apply ourselves to the same practical and common-sense development and utilisation of our turf resources, as years ago the people of the Netherlands did. By doing so may we not reasonably look, in time, to results as advantageous and as useful to us, as they have been and now are to the inhabitants of Holland?

TURF INDUSTRY.

No. III.

In the two preceding Papers the writer's object has been to show that, if we are henceforth to have any additions to our supplies of fuel from peat, upon anything of an extensive or generally useful scale, it is mainly to ordinary turf that we must look, at least for a considerable time to come; and he has stated the grounds upon which we may in future find it to prove a very serviceable fuel, if only increased attention and efforts be given to its production. These conclusions may be unattractive at the present time when the hope of some new solution of the peat question is uppermost in most minds, but in the end they will be found both useful and truthful. They rest upon the fact, that no mechanical systems yet known for making improved fuel from peat are capable of giving large supplies upon a commercial basis, at any reasonably early day; and upon the further grounds, that the only improvement which the best mechanical system can effect in peat consists solely in the increase of its density. This improvement, however, is not called for by the whole mass of any ordinary peat bog; its desirability is more particularly pointed to the upper or more fibrous portions, which are after all only a moderate part in comparison with the dark brown and black peat of most of our Irish bogs, and for all general purposes these latter qualities of peat do not need any mechanical systems for their improvement.

Looking at the subject in this way, we narrow the question of improved peat fuel manufacture, and we are enabled to see what a large field of useful capability there exists entirely outside of it, and wholly independent of it. The writer thinks it is much to be regretted that in the public discussions that have taken place of late upon the peat question, the distinctions here made have not been kept more fully under notice, and that so much should have been expected from mechanical systems, when in point of fact their values and capabilities are limited by the circumstances already mentioned.

With these preliminary remarks, I shall now refer to the mechanical systems themselves, so far as they have at present any importance, that they may be presented together for examination and consideration, and the writer trusts to be able to offer in them a concise *resumé* of what has been effected for the production of improved peat fuel by manufacturing processes, up to the present time.

Amongst the earliest efforts that were made, we find endeavours which, if they had proved successful, would very effectually have solved the difficulties in connexion with peat. The objects proposed were, to free the wet peat from at least most of its water, by direct mechanical pressure, and at the same time and by the same operation to effect the compression of the peat itself so as to increase its density. For this purpose various modes of applying powerful mechanical pressures were employed, but without any useful practical results whatever. The gain effected by the partial expulsion of the water from the peat was more than lost in the difficulty which was afterwards found to exist in drying the peat itself, owing to the compression to which it had been subjected. It was found that although as much as forty per cent. of water might be thus removed out of peat containing perhaps as much as eighty-five per cent. of water, yet that peat of the same kind not subjected to the pressing process, and containing the entire percentage

of water, would practically dry in air to a point when it would contain not more than twenty per cent. of water, just as soon as the pressed peat would, although the latter had already lost forty per cent. of its water by pressure. To this unsuccessful result was added also the fact that the increase in density effected by the pressure was found to be very trifling. For instance, peat which, unpressed and dry for use might weigh twenty-five pounds to the cubic foot, would not have weighed much more in the same condition than perhaps thirty pounds to the cubic foot if it had been in the first instance subjected to pressure. When we look at these results in connexion with the mechanical arrangements requisite for effecting powerful pressures, and couple them also with the necessarily slow action of all such machines, we can, without difficulty, see how hopeless all such attempts were, and how ineffectual and wholly futile they must continue to be, as long as the nature and conditions of peat remain unchanged.

The application of pressure to wet peat having failed in the most complete and most conclusive manner to justify any useful expectations from that mode of procedure, we next find invention proposing to itself to dry the peat in the first instance, and then to subject it to pressure; and herein a practically successful result was realised. This system, which is known as "Exter's," from the name of its inventor, was first introduced in Germany, and it is at present carried out in works of considerable extent at Haspelmoor and at Kolbermoor in Bavaria. The former are carried on by the State for the use of the Government railways, and the latter are in the hands of private owners, who produce the compressed turf also for railway purposes.

According to this system, the peat bog to be worked is in the first place well drained, and the portion from which the peat is to be obtained is made level. From this level surface a thin layer of peat is in fine weather harrowed off, either by

ordinary labour, as at Haspelmoor, or by steam power as at Kolbermoor. It will be apparent that the surface which yields this thin layer of peat has from exposure to the air already lost some of its moisture, and that the loose layer itself when made up into small heaps, or "windrows" in the condition of a fine turf mould, soon also loses still more. After being thus partially dried by a short exposure to the sun and air, this fine loose peat, the "torfpulver" of the Germans, is removed to capacious storing sheds, where it becomes the stock of raw material for the future manufacture, and its accumulation during the favourable portions of the year forms the sole work to which attention is given upon the bog, as the manufacture is carried on in adjoining buildings. Here the fine peat mould is more fully dried by artificial heat, and in the manufacture it falls into horizontal tubes, in which it is compressed by rams or plungers moved by powerful eccentrics, actuated by steam machinery. By this means the fine peat mould becomes solidified into a dense turf fuel; but as its compactness of body is entirely due to mechanical pressure, there is an absence of that more perfect natural cohesion and density, to which reference will be made further on, when we shall come to treat of dense turf manufacture. The cost of this compressed turf was ascertained in the latter part of the year 1872 by the investigations that were then made to be about twelve shillings per ton: but it was obvious that with this amount there should be taken into consideration large original outlays upon fixed erections and machinery of a powerful class, with its attendant liabilities.

One of the advantages claimed for this method is its capability of being carried on continuously, if sufficient quantities of peat mould be stored under cover during the portions of the year when it can be got advantageously, as in that case the manufacture may go on uninterruptedly almost all the year round.

The works which were erected at Derrylea, near Monasterevan, in this country, were essentially upon "Exter's" system, but the cost of manufacture, coupled with the average cheapness of coal at the time, decided entirely against their commercial success. The best results of well arranged and economically conducted works upon this system in Germany show the costs of production to be twelve shillings per ton. It was therefore not possible to sell the compressed turf of Derrylea in Dublin, at about that rate per ton, including its cost of transport from the works, and at the same time to hope for profits from the undertaking.

The advantages claimed for this system of compression consist in obtaining the peat in a condition favourable to its rapid drying on the surface of the bog, whereby the large percentage of water that must be handled and carried, and afterwards removed by evaporation in the making of ordinary cut turf or of dense turf, is very considerably, if not for the most part, got rid of. On the other hand, the extent of the mechanical arrangements that are necessary for the manufacture, coupled with the risks and interruptions that are unavoidable from the employment of so much mechanism, and the high rate of the costs of production, have been serious obstacles to its more general adoption. The reader will not fail also to notice that as this system necessitates the working of the peat, layer after layer, from the surface downwards, the utilisation of the deeper and more valuable peat in such cases becomes postponed to a remote day.

In this system, the loose air-dried peat mould is subjected to a further drying by artificial heat before it reaches the compressing portions of the mechanism. At the Kolbermoor Works the exhaust steam from the engine is employed for this purpose; after its exit from the cylinder, it is made to pass through a series of hollow iron floors, over which in an enclosed chamber the peat mould is carried by screws or

spirals. When in this manner it reaches the stage at which it is to be compressed, it still contains some diffused warm moisture, which is an important element in the process, and one specially favourable to the compression that then takes place. This is considered to be owing to the softening of the fibrous portions, and to the kindlier state in which from this steaming arrangement the whole mass is presented to the direct action of the rams or plungers of the machine.

Compressed peat made in this manner weighs about seventy lbs. to the cubic foot, and is ready for use immediately after it has been compressed. At Kolbermoor, it issues in an almost continuous length for several feet along a wooden shoot upon which it travels, and it breaks off in portions by its own weight when it extends a short distance beyond the termination of the shoot. It is there received in baskets and transferred to railway wagons which stand under this portion of the works for its reception.

The heating power of this compressed peat for locomotive purposes, as compared with ordinary turf of the same quality, but uncompressed, and with four varieties of German coal, has been ascertained by the test of large and lengthened experience in its use, by the managing Direction of the Bavarian State Railways, and from that source the following particulars were obtained. Adapting them to our standards of weight, the results are as follows, and they may be looked upon perhaps as the most complete modern data yet laid before the public, as to the comparative heating powers of turf and coal, weight for weight:—

5000 lbs. of ordinary cut turf = 5000 lbs. of compressed turf.
5000 lbs. of compressed turf = 2560 lbs. of coal from the Ruhr.
" " " = 3100 lbs. coal from Bohemia.
" " " = 3230 lbs. of coal from Zwickau.
" " " = 3945 lbs. of coal from Miesbach.

Taking the mean of the above four varieties of coal, we arrive at this result in tons, that, at least for locomotive purposes, one ton of turf, whether uncompressed or compressed, has been found equal to slightly more than six-tenths of a ton of average coal. The turf here referred to must however, be taken on the whole as of a light fibrous nature, such as would be obtained from the upper portion of an average Irish red bog at a few feet from the surface.

These particulars are also of importance, as evidencing the fact that in any given weight of compressed turf, there is not any greater *quantity* of heat than in the same weight of ordinary uncompressed turf, other conditions being the same in both. The advantage is, that as in turf which is compressed the quantity of heat is contained in a smaller bulk or space than in turf which is not compressed, so its effective heating power, in like manner, becomes more concentrated and intense. To this advantage we have also to add the increased facilities for carriage and storage that compressed or dense turf possesses over ordinary light fibrous turf.

In support of the views already put forward by the writer, he thinks he is entitled to rely upon these results, as sufficiently demonstrating the fact that mechanical systems have, on the whole, little value for peat, which in its natural condition will give a fairly dense turf when cut in the usual manner with the slane; and as warranting him in saying that in the end we shall find more substantial benefits to result from increased attention to the utilisation of peat that needs little or no mechanical treatment, than we are likely to have for a very long time to come from any mechanical systems whatever.

The foregoing system of compression may be looked upon as the only one in which a practical success has attended efforts made for giving density to peat by mechanical pressure. There have been attempts by some persons at im-

provements or modifications upon this principle, but as they have not given any practical results equal to those of Exter, it is unnecessary to refer more particularly to them here.

The systems which next call for notice all belong to one class, and they comprise the different methods employed for giving the desired density to turf, by the mixing, pulping, or tearing up of raw peat. Upon this principle every system for the production of *dense* turf, as distinguished from *compressed* turf, is more or less based. In compressed turf, properly so called, the density is given, as we have seen, by the direct application of mechanical force, whereas in dense turf, the density arises from the natural shrinkage and aggregation of parts that takes place to a remarkable extent in peat, if in the first instance it be subjected to any process by which in the wet condition its fibrous structure is broken up, and the whole is reduced to a mortar or pulp-like state. In addition to the density which ensues from this mode of treating peat, it is found that, in drying, the contained water is more speedily parted with than it is from turf which is not subjected to this treatment,—in itself an important feature in the making of dense turf.

Upon a small scale we find this principle carried out in the method of making hand turf in some parts of Ireland, and upon a very large scale in the kneading and mixing by the feet, to which the peat extracted from under water in the Netherlands is subjected for its preparation as fuel.

The earliest attempt, however, for making dense turf by mechanical arrangements appears to have been that of Challeton in France. In the year 1860, the works at which the system adopted by Challeton was carried out were examined and reported upon by Dr. Dullo, in the course of his investigations in reference to the methods of working turf then in operation in Europe, and from his Report I shall

take the liberty of giving the following descriptive particulars of this system.

"The works at which the Challeton system was carried out in the year 1860, were those of M. Challeton himself, at Montauger near Paris, and those of M. Roy, at St. Jean, near the Neufchatel Lake. Both of these concerns did not leave an impression on me that this description of turf working could be carried out with profit, although the method itself can produce a material equal to what it claims. Both concerns work as follows :—The turf cut from the bog is brought to the works by tramway or canal, and the raw peat is then passed into a tearing apparatus, which consists of an arrangement of iron rollers or cylinders, about four feet long, by one and a half foot in diameter, and fitted all over their surfaces with knives or cutters four inches long. In this apparatus the peat has much water added to it, so that it becomes a thin pulp, which is raised to an upper floor by a chain pump, and there it runs over fine sieves in order to be freed from all coarse fibres. This fine peat pulp is then conveyed into drying basins. These latter are pits of different sizes, at the least forty feet square, by one or two feet deep. The bottoms of these pits are covered with rushes or reeds, which serve as a porous bed to allow the surplus water to drain away from the peat pulp. By degrees this pulp becomes sufficiently firm to admit of being cut into pieces. These are laid to dry in drying sheds, and they are subsequently more fully dried in artificially heated chambers.

"Peat treated thus accquires a very considerable density, but it is not, however, altogether correct to judge of the goodness of dense peat only according to its density, which if carried too far, is not advantageous.

"This very dense peat burns with little or no flame, and upon reaching complete ignition, it falls to pieces, as it has

been entirely deprived of the binding or cohesive effect of the fibres.

"This system labours under the defect of being entirely dependent upon the weather, and of having but poor capabilities for large production. In wet summers it will take some weeks before the thin peat pulp in the filter beds becomes sufficiently shrunk together to admit of its being cut into pieces, and the subsequent air-drying will take an almost equally long time, so that in this system one is just as dependent upon the weather as in the usual method of cutting ordinary turf, and with the disadvantage that only a very trifling production is practicable, even if the number of these peat pulp pits be very considerably increased.

"Keeping under consideration the cost of the erection of such a concern, the conviction follows, that it and the cost of production are not so low as to give this system any superiority.

"It is not possible to obtain from the proprietors a sufficient account of the costs of production of dense turf by this process; but it may nevertheless be tolerably safely assumed that 100 lbs. weight, in marketable condition, cannot cost less than about seven pence, equivalent to about thirteen shillings sterling per ton.

"Looking to the small production, the working cost is too high, and the system is one that cannot be recommended for adoption."

More recently some improvements have been attempted in France upon this system of Challeton. Writing in support of it, Ernest Bosc, in 1870, states the cost of production as being then about nine shillings per ton.

As from its being re-produced in a modern method, some interest attaches to this system of diluting peat with water, I have thought it useful to enter into these details of the original undertaking, as they were carried out in practice by

Challeton. It is possible that improved arrangements and more powerful mechanism may admit of the production of dense turf of this class at a cheaper rate than its original cost of thirteen shillings per ton, at Challeton's works; but it remains yet to be seen whether in the quality of the turf to be made, and in capability and costs of production, this system can claim any advantages over those which merely subject the peat to a tearing or mixing process without the addition of water. At an early stage in the discussion of the peat question, the writer disputed the grounds upon which advantages were claimed for Challeton's method; but as steps have been since taken for its practical testing upon a commercial scale, upon the basis of a sufficiently large working in this country for the purpose, the writer considers that he should now leave to results the decision of the question. He wishes that no difficulties shall be placed in the way of the practical testing of that system with the modern mechanical arrangements claimed for it by Mr. Box, to whom is now due its reintroduction as one of the methods proposed to the public for the making of improved turf fuel upon a large scale and at a cheap rate.

About the time of Challeton's efforts in France, the making of dense turf was undertaken by the simple mechanical tearing up and mixing of the raw peat, by Weber at Staltach in Bavaria, and this may be looked upon as the parent system of all those that tear and mix together the peat without the addition of any large quantity of water.

The arrangement employed by Weber consisted of a vertical vessel of the pug-mill type, in which an iron shaft revolved, fitted with cutting blades; in the interior of the vessel, at the sides, other blades were attached, between which those on the shaft passed as it revolved upon its axis. The peat was raised to the mouth of this tearing and cutting apparatus by an elevator, and by the action of the knives or blades it

became cut and torn, and issued from an orifice in the bottom in a mixed condition, as a mass of pulp. It was then shaped in moulds and dried for use.

The mechanical arrangements employed by Weber became the subject of subsequent improvements, of which the most important were those introduced by Mr. C. Schlickeysen, a manufacturer of brick-making machines in Berlin. This gentleman has become so identified with the making of his turf machines ("Torfpressen") that the system which originated with Weber is now more usually known as "Schlickeysen's," and it is that which has received most attention from those interested in the peat question abroad.

The arrangement invariably consists of two parts; first, the press or vessel in which the peat is torn and mixed together; and next, the motive power for the purpose, proportioned to the work to be done,—usually a portable steam engine varying from four to ten or twelve-horse power.

The press or machine of Mr. Schlickeysen is a cast iron vertical vessel, similar in shape and size to an ordinary clay pug-mill. In it a central iron shaft revolves, fitted with strong blades or arms for tearing and mixing the peat, and they are so shaped and arranged upon the shaft as to operate with a downward screwing or forcing motion upon the peat at the same time that they tear it asunder. By this means the disintegrated mass of peat is forced downwards and outwards, laterally, through a mouth-piece near the bottom of the machine. In this mouth-piece there are apertures, usually three in number, each about three inches and a half square, through which the peat is forced by the action of the machine. As it issues, it is cut off in pieces by hand, each about ten inches long. These pieces are placed on boards about three feet long by twelve inches wide, and on these boards they are carried by barrows to the spreading and drying ground where they are laid out for drying, and the boards are brought back again to the machine to be filled in their turn.

From the surface of the bog an inclined plane of timber is in some cases laid, which reaches to a staging at the mouth of the machine, and on it the peat is wheeled up in barrows; in other cases it is raised to the machine by an elevator. On the staging or platform one workman is constantly employed to keep the machine fed with the peat, and as far as possible to remove any pieces of roots or other unsuitable substances that might otherwise enter into the machine with the peat.

Peat treated in this manner dries freely in the open air in averagely favourable weather; after a few days it is in a condition to be but little affected by rain, and generally it is found to be sufficiently dry for heaping finally together in from four to six weeks. The smallness of the pieces, coupled with the effects of the mixing process, contributes largely to this result.

In the wet condition the average sizes of the pieces of peat, as they are cut off on issuing from the Schlickeysen turf press are about ten inches long, by three and a half inches square, and in the air-dried condition they become reduced to sizes varying from one-fourth to one-sixth of the original bulk or volume of the peat, the differences in shrinkage being due to different varieties of peat.

Near Brandenburg in Prussia, one of these turf presses, of small size, was examined at work in the autumn of the past year, and its capability of production was found to be about 10,000 pieces of peat daily, which in the air-dried condition gave about four and a half tons of dense turf. This machine was one of the smallest size made for steam power, and the portable engine was about four-horse power. The pieces of peat in air-dried condition were here on the average about seven inches long, by two inches square, and in size less than one-fourth of their original bulk as they came from the machine. The peat was of inferior quality, and was obtained from a grassy moor or bottom; in order to procure

it, an excellent surface pasturage had to be removed. This dense turf was made by the owners of some brickworks for their own use in burning bricks, in combination with ordinary turf, in a Hoffman kiln. The bricks thus burned were examined, and were found to be of excellent quality.

A turf press of the largest size of those now made by Mr. Schlickeysen was examined at work at Herzfelde in Prussia. This machine was provided with two mouth-pieces, each at opposite sides, and the portable engine for working it was about eight-horse power. The capability of production of this machine was found to be about 35,000 pieces of peat in twelve working hours, equivalent to about fifteen tons of air-dried dense turf. The persons employed here for this amount of work, from the raising of the peat to the spreading of it in pieces on the drying ground, and including the engine-man, numbered twenty-two, of whom six were women.

From observations made on the spot, and from the data then obtained in reference to the costs of production by both machines, it was estimated that the labour cost might be taken at six shillings and sixpence per ton of dense turf, made in the foregoing manner.

In the two machines now described, we have examples of the smallest and of the largest machines now made for steam power by Mr. Schlickeysen. At an early period in this industry some turf presses with much greater capabilities of production were produced, but they were not found to be as desirable, or as successful in actual practice, as those of smaller size; and accordingly, Mr. Schlickeysen now prefers to make machines of four sizes for steam power within the limits of those that have been described. As the average weekly production of the largest size is, under favourable circumstances, scarcely more than ninety tons of dense turf, it is obvious that a large production can be effected by this system only by

the multiplying of the number of turf presses. In actual practice, however, one week with another, it would not be safe to count upon more than from sixty to seventy tons. On the other hand, this or any like system presents the advantage that where only moderate quantities of dense turf are required, as for instance for some special uses, they can be produced by a very simple plant and a moderate outlay, and without requiring any erections, except some shedding for the more perfect drying and storage of the dense turf. This shedding is not, however, indispensable, although it is undoubtedly a desirable portion of any arrangements for the production of turf in Ireland. No sheddings were used for the drying or storage of the turf at the works which have been now described. The pieces of peat were simply dried in the open air, and then put together in heaps for use.

A modification in some respects of the mechanical arrangements of Schlickeysen has been made at works of some importance, which are carried on by Prince Schwarzenberg, near Gratzen in Bohemia.

In this arrangement the tearing of the peat and the forcing of it from the mouth-pieces of the machines are effected by separate portions of the mechanism. In the system of Schlickeysen, both operations are effected by the revolution of the shaft, owing to the shape and disposition upon it of the blades with which it is provided. In the arrangement at Gratzen, the operation of tearing and mixing the peat is effected by a pair of horizontal rollers, with short blades fitted all over them, and these rollers are placed in the upper part of the machine. In the lower part there are horizontal screws or spirals which receive the torn peat, as it passes through the rollers, and it is then forced forward by the screw-like action of these spirals to the mouth-piece of the machine. Here there is a further divergence from the system of Schlickeysen. Instead of issuing in shape through

apertures, and ready for removal in pieces to the drying ground, the peat comes out as a continuous and shapeless mass. This mass of pulp is then removed in barrows to a spreading and drying ground, previously levelled and prepared for the purpose, and it is there deposited and made into an uniform stratum of peat, by workmen who knead and tread it with short boards attached to their feet. In this respect the course adopted is the same as that employed by the turf-workers of the Netherlands in their treatment of the peat raised from under water in the low peat beds there. The thin bed of pulped peat when thus formed is marked with lines, and then cut and dried in the open air. In the dry condition the pieces are about seven inches long by three inches wide, but in thickness not more than an inch and a half. This diminution of the thickness is particularly noteworthy, as conducive to the speedier drying of the peat.

At these works there were, in the year 1872, nine machines, worked by as many portable engines, and the total quantity of dense turf made there in the season was stated to be about 7,000 tons, at a total cost for production of about six shillings and nine pence per ton. The experience of the manager of these works was more favourable to the distribution of the peat in a stratum on the drying ground as was practised there, than to the obtaining of the pieces in a finished and shaped condition from the mouthpiece of a machine, as in the system of Schlickeysen. The peat is raised to the machines at Gratzen by elevators, and the portable engines and machines are moved forward on the bog upon temporary timber framings provided with rails, according as the excavation of the peat is proceeded with. The dense turf produced here was chiefly used for sugar-works which are carried on by members of the Schwarzenberg family at some distance from Gratzen, and to which works it is conveyed by railway. In the treatment of this peat in its passage through the tearing rollers, some water was added,

to facilitate the operation, but the quantity was not considerable. Assuming seven of these machines to have been constantly at work for the turf-making months, extending here from April to August, we may average the working capability of each machine at about seventy tons per week, or one thousand tons for the season. These figures agree pretty nearly with the observed results of the Schlickeysen machines, as well as with those which will be next mentioned.

Upon the same principle—but with some other modifications in the mechanical arrangements—works for the making of dense turf are carried on in the province of Drenthe, in the Netherlands, by Mr. Rahder. The points of difference, although trifling, are yet worth notice; and with them before him, and the descriptive accounts already given, the reader will have a fair idea of what has been effected up to a very recent date by different minds upon the continent, for the solution of the problem of improved turf manufacture, upon the principle of tearing and mixing the raw peat.

In Mr. Rahder's system the tearing mill or vessel is a vertical one, made of wrought iron plates, and is about six feet in height, and three feet in diameter. In it a vertical iron shaft revolves, fitted with arms for tearing the peat; this shaft does not descend to the bottom of the vessel, but is supported at a point about eighteen inches above the bottom, by a strong iron cross piece in which the foot of the shaft revolves. The bottom portion, which is unoccupied by the shaft, communicates at one side with a pipe which terminates in a mouth-piece, and in it a horizontal screw or spiral from two to three feet long, and from twelve to thirteen inches in diameter, revolves, by which the peat as it descends from the mill is forcibly squeezed outwards through three orifices in the mouth-piece, and as it issues is cut off in pieces about one foot long by three or four inches square, which are then dried in the open air.

This machine is constructed upon a frame-work of iron which is extended to a short distance at each side to give a steady base, and it is mounted upon wheels to the same gauge as those of the portable engines. Temporary rails are laid upon the bog beside the face of work from which the peat is to be excavated, and the machine and portable engine travel onwards as the work proceeds. The portable engines are each about ten-horse power, and the production of each machine was about 20,000 pieces of peat, equal to about fourteen tons of dry dense turf, daily, during the working season. The total number of persons employed for this production was twenty, and the dense turf was sold at these works at a rate equal to about ten shillings and sixpence sterling per ton.

The total production of dense turf at Mr. Rahder's works, for the turf-making season of 1872, was about 5,500 tons, which represents the working capability of five machines and five portable engines.

The writer had the benefit of an interview with Mr. Rahder, and was informed by that gentleman that he had arrived at the arrangement described, after a careful examinanion of other existing systems; and Mr. Rahder stated, as the result of his experience, that fixed erections for peat works are not desirable, and that a system which can conveniently follow its work is the one of all others most likely to be successful. With this conviction he had his mill constructed as described, so that it was in all respects as portable as his engines were, upon the temporary lines of railway upon the bog.

In addition to the making of dense turf, Mr. Rahder also carried on extensively the cutting of ordinary turf for sale, and the combined industries gave employment to about three hundred persons during the turf-making season, which

in Drenthe extends from the latter part of April until September.

Upon his visit to Mr. Rahder, the writer had an opportunity of vividly realizing all round him, in this portion of the province of Drenthe, the descriptions already given of the changed aspect of the country from its original condition, of moor and bog, into luxuriant plains and cultivated fields, interspersed with timber, orchards, and gardens, and crowned with houses of taste, and not unfrequently of elegance. But for all these things, the people toil assiduously. The humblest labor is here honorable, and all who toil are cleanly, and well clad, and apparently content. Industry has evidently marked out these northern people for her own.

On referring to the rates at which turf was sold at the Hague in the Autumn of the past year, we find that the machine-made dense turf of Mr. Rahder did not bring a higher price there than was obtained for the best qualities of turf from the low peat beds of the Haarlem district, which were made by the kneading and treading process, as described in the last Paper, the weights being in both cases much the same.

We may here terminate our descriptions of the systems in use in the countries mentioned, for the making of dense turf, upon Weber's principle of tearing and mixing the raw peat; and for purposes of continuity and comparison, we shall next draw attention to the machine lately introduced in England, by Messrs. Clayton, Son, and Howlett, of London. How far it may be superior to those which have been described, or essentially different from them, and to what extent it is likely in point of capability of production to help us to an improved solution of the peat question, are matters upon which, from the particulars which shall be now given, the reader will be able to form a competent judgment for himself. We have been told by some who have described this machine that it has

been successful, and we shall therefore examine it, in connexion with those already noticed.

The Messrs. Clayton state that the objects aimed at by them, in their patented process, are firstly to get rid of as much water as possible by drainage and squeezing, and then to thoroughly cut up the fibrous portion, so as to release the water which was previously held in the fibre, and to reduce the whole to an uniform state of pulp.

To accomplish the squeezing out of some of the loose or free water of the peat as it comes from the bog, these makers fill the raw peat into "squeezing-trucks," and by a pressure then applied to the peat they seek to deprive it of a portion of its water, on its way from the bog to the machine.

With respect to this portion of the process we need not make much investigation, as experience has more or less shown, that where any ordinary peat is to be subjected to any mixing or pug-mill process, it is not usually desirable to deprive it of water before it passes into or through the machine. Any gain effected in that manner would be, perhaps, more than neutralized by the greater friction of the peat in the machine. We have noticed that, at Gratzen, water was added to facilitate the tearing and mixing operation, and it is not easy to see how the system of squeezing-trucks in Messrs. Claytons' system can be looked upon as of much utility or importance for the manufacture.

For reducing the peat to a state of pulp, it is received in a vertical mill or vessel of the usual type, furnished with an internal shaft with blades or arms. It passes thence to the lower part of the machine, in which there is an arrangement upon the principle of a screw or spiral, with revolving cutters and fixed knives, whereby it is subjected to cutting, coupled with some amount of pressure, and it is ultimately forced through a mouth-piece, where the arrangements for

receiving and cutting it into pieces are, on the whole, similar to those used in most brick-making machines.

The special object aimed at by the cutting action of this machine, being the reduction of the peat to a finer state of pulp, than is effected by any of foregoing systems of the pug-mill class, we are led to inquire if such a very minute division of the peat is necessary or desirable. To this inquiry the best answer that can be made is, to refer to dense peat made by any of the former systems, by the rough tearing and mixing of the raw material, and to ask ourselves if the results are sufficiently satisfactory for all general purposes; and to this we think the answer must be in the affirmative. As noticed by Dr. Dullo, the results of the comminution of peat, if the pulping be carried too far, are not advantageous.

As in the first of these Papers reference was made to the machine of Messrs. Clayton, in reference to its capability of production, we need not here enter into any further details; it only remains for us now to observe, that in this respect it does not appear to have any advantages over the mechanical arrangements of the same class, that have been already described; at the same time that there appears to be, in the arrangement of the Messrs. Clayton, a greater amount of elaboration in the mechanism than is desirable for peat work, for which simplicity coupled with effectiveness should be at all times the best recommendation.

The peat question is not altogether an Old World one; it extended itself to America, and we have now to notice the principal systems adopted there for its solution.

In the United States, the mechanical arrangement of Leavitt is that which has attracted most attention. It is essentially the same in principle as those already noticed; the only differences consist in the constructive details of the machine, of which we take the following description from Leavitt's work, entitled "Facts About Peat."

"The machinery consists of a strong tank or cistern, three feet in diameter and six feet high, supported on a stout frame-work, about four feet above the floor of a suitable building."

"Within the tank, and firmly fixed to its sides, are numerous projections of a variety of forms, adapted to the treatment of the material in its several stages as it progresses through the mill, which is divided into three apartments: through the centre of the tank revolves an upright shaft, to which are attached knives and arms varying in form and structure, to correspond with the stationary projections in each apartment; below the tank is a receiver or hopper; and under this is a moulding or forming machine two feet in width and twelve feet long, which receives the condensed material from the hopper, and delivers it in pieces of any desired form and size. The whole is adapted to be driven by an engine, from six to ten-horse power respectively for the two sizes of machines, of the capacity of fifty and one hundred tons each, of crude peat per day of ten hours."

This capacity, under average circumstances, may be taken to represent at best not more than from eight to fourteen tons daily of ordinary air-dried dense turf, and the cost of production was stated by Mr. Leavitt, in 1867, to be then two dollars per ton.

In Canada the system of Mr. Hodges has been carried out, and it is the one sometimes referred to in this country as the Canadian Peat Company's system. While the principle is the usual one of the mixing and pulping of the peat, the arrangements for the whole process of manufacture are entirely different from anything that has been yet described. It is, however, *an indispensable condition* for working upon this system, that the bog should yield or be supplied with water sufficient for floating the entire mechanism; in other words, that the bog as excavated shall become a pond or lake.

For the purpose of working on this system, upon a bog capable of supplying the necessary water, a barge or scow about eighty feet long, by sixteen feet beam and six feet deep, is constructed at one end of the bog and launched into a dock made to receive it. This barge contains the engine and all the machinery for the excavating, pulping and distributing of the peat. The excavating of the peat is effected by a pair of large iron screws, eleven feet in diameter, placed in the front of the barge, which are driven by the steam engine, and in this manner not only is the peat obtained but the necessary water-way or canal is formed for the progress of this floating peat factory. The peat thus raised is subjected to a tearing and mixing process, by which it is reduced to a pulp having the consistence of well tempered mortar.

From one side of the barge or scow, and at some distance over the surface of the adjoining bog, a long spout or distributor extends, for a distance of ninety feet, by which, as the barge proceeds, the peat pulp is distributed in a continuous stratum about nine inches in thickness and nearly ninety feet in width. This layer of peat is subsequently divided into pieces, and dried in the open air for use. The levelling and preparation of the spreading ground for the width of ninety feet along the intended line of working, are portions of the work that require and receive much attention, and shallow drains are formed to favour as far as possible the drying of the stratum of peat pulp.

Useful results have attended this system in Canada, but as has been stated, the conditions for its application are special. From some returns that have been given, the costs of production appear to be less than two dollars per ton, and the capability of production of one of these floating works may be equal to about three thousand tons of dry dense turf for the season. The cost of one barge or scow with all neces-

sary machinery for the manufacture, was in the year 1866 estimated as then costing about ten thousand dollars.

If in addition to those now mentioned, we include the system of Mr. Box already referred to, the reader will have before him a compendium of such systems for the production of improved fuel from peat, as are now before the public, and they include in principle, all from which as far as invention has as yet progressed, any practically useful results can be expected.

It remains only to say a few words in reference to Mr. Box's system. In principle it is essentially the same as that of Challeton, already described, but Mr. Box states that he expects by an adaptation of the machine known as "Carr's Patent Disintegrator," coupled with improved filtering beds, and cutting tools, to obtain results in the commercial production of dense turf which were not realised by Challèton.

As commercial success is the end to which all efforts in the peat question should tend, and as Mr. Box's system has been adopted for commercial test in this country, upon a scale sufficient to ascertain its capabilities and value, any further discussion of it, than what has already taken place in the press, would be out of place, until the results themselves shall be laid before the public.

In a concluding number, the writer will refer, as far as may be useful, to some of the principal treatises that have of late years appeared upon the subject of peat, which may be consulted by any who are desirous of investigating the subject more in detail; and he trusts that with the issue of that Paper his readers will then have before them, such a review of the position and prospects of the peat question up to the latest period, as may tend to render more precise, the probabilities of the extent to which we are limited at present for the solution of that question upon a large scale, by means of mechanical systems.

TURF INDUSTRY.

No. IV.

If we summarize the several mechanical systems at present of any importance for peat-fuel manufacture, and of which the principal modern arrangements have been noticed in the last Paper, we arrive at the following conclusions :—

1. That the main object sought to be attained in all the systems, taken as a whole, consists in increasing the density of the peat, so as to present in a smaller space, and consequently in a more effective condition, the quantity of heat already possessed by any given weight of peat. But there is not any increase made to the original quantity of heat, inasmuch as there is neither any addition made to the peat itself, nor any element unfavourable to the development or generation of heat withdrawn from it, in the process of manufacture.

2. That the value of all such systems is therefore proportionate to the need that exists for effecting density, and that this value is variable, according as peat in the natural condition is capable of yielding a more or less dense fuel, without requiring any mechanical treatment for the purpose. In other words, that while it would be desirable to subject peat, in which the fibrous structure exists to an extent unfavour-

able to density, to one or other of those mechanical processes, for its improvement, any such treatment would be practically of little or no use for peat, which when cut in the usual way will give a fairly dense turf, without the aid of mechanical systems.

3. That the several systems of manufacture resolve themselves into two classes, as follows :—

COMPRESSED TURF,—in which the desired density is given to the peat, when in the condition of a fine dry turf mould, by the direct action of mechanical force, or pressure, —as was done at Derrylea, near Monasterevan, upon the system known as "Exter's;"—and,

DENSE TURF,—in which the density is obtained by tearing, and mixing the raw peat in its wet condition, so as to break up the fibrous structure and reduce the whole to a mass of pulp. In this state, peat offers itself under the most favourable conditions for becoming dense, with the additional advantage of drying more speedily than it would if simply cut as ordinary turf.

Upon the principle of compression, the only mechanical system that has been carried into practical effect is that of Exter, already noticed. Its attendant circumstances, however,—involving as they do, large outlays, and considerable liabilities, together with a high cost of production,—have confined its adoption to a few early undertakings, some of which are still found at work upon the Continent.

The principle of making dense turf, however, by tearing and mixing the peat as raised from the bog, has given rise, as we have seen, to a variety of systems, all designed for the same purpose, but differing more or less in their constructive

details and arrangements. In almost every instance, however, the capability of production of each machine is limited to a moderate quantity, and for large supplies it is necessary to increase proportionately the number of machines.

With these particulars, and what has been already stated, the reader has now before him *the sum and substance* of our present capabilities and resources for the solution of the peat question by mechanical systems. It would be unwise to conceal from ourselves that any such solution cannot for a long time be otherwise than of such a partial nature as to be practically of little or no moment for increasing our supplies of turf-fuel for general purposes, and that under such circumstances our plain duty is to look to the capabilities that are to be found in the production of ordinary turf, if that plain industry be only encouraged and promoted in this country, as it has been elsewhere. Combined with it, the making of dense turf by mechanical arrangements may, from small beginnings, grow into an industry of importance, and it may be said that the very surest hopes for its progress lie in the extended production, and use of ordinary turf, in the first instance.

Although for all useful purposes, the writer might limit his illustrations of mechanical systems of treating peat to what has been already detailed, yet to render these Papers more complete, the following particulars are added, of methods in use in France for making dense turf there.

The manufacture in France is chiefly confined to that variety of peat which is known as marsh peat, and which for the most part lies completely under water, without any natural capabilities for drainage. It may be said to correspond to the low peat-beds of Holland, and previously to being worked its surface is often covered with a grassy vegetation, and the usual growths of humid soils. As water is found within a very short distance from the surface, this

marsh peat can be raised only by certain special modes of working. In some cases dredging is resorted to at some stages of the work, but in general the peat is raised by implements which are designed specially for the purpose. Of these, there are two kinds; one for direct use by a workman, and the other a mechanical arrangement for raising larger quantities than can be got by hand-labour.

The implement for direct use by hand is called the "grand louchet," and it consists of a box-shaped tool, made of thin wrought-iron bars, or of sheet-iron pierced with holes and attached to a light iron frame, in length about four feet three inches, open at the top, and bottom, and also in front, and in width and depth from four and a half to five inches square. In other words, a long and comparatively narrow and shallow two-sided box, open at the ends, and at the front. At one end, this implement is provided with a socket well riveted to the under part, by which it is securely attached to a round wooden handle, which is usually from twenty to twenty-five feet long, and sometimes longer, to admit of working at considerable depths. With this tool, held as nearly perpendicular as practicable, the workman severs the peat from the mass lying under water, and raises it without any great difficulty, as the specific gravities of the water and of the peat do not very materially differ. According as each prism-shaped piece is raised, it is either divided into portions of about equal length, to be dried for use as ordinary sods of turf, or the entire is subjected to a mixing operation, with shovels and wooden rakes, and afterwards moulded by hand in wooden moulds.

These moulds are made of light timber, and each usually contains four divisions, by which four "briquettes" or pieces of peat are formed at a time, each about thirteen inches long, and from three to three and a-half inches across in width and

thickness. When dry, these "briquettes" of dense turf are usually found to have become reduced to about one-fifth or one-sixth of their original size.

The mechanical arrangement is known as the "louchet mecanique," and is upon a much larger scale than the "grand louchet;" it is mounted upon a wooden frame-work, and fitted with a rack and wheel movement for the up and down motion of the cutting box, which latter is provided with a pair of hinged valves in the bottom, opening upwards, which close and retain the piece of peat when it is being raised. As already mentioned, the labour of raising the peat in this system is very trifling, as the peat moves in water of about the same weight with itself, and according as the continuous upward motion of the machine brings the peat over the water, it is cut out of the "louchet" by a workman who usually stands in a flat-bottomed boat in front of the implement, and the mass of peat thus obtained is then carried to the working floors, and moulded into "briquettes" of dense turf.

This machine has an onward motion upon the frame-work on which it is erected, which is so regulated, that after the making of each cut, it is advanced forward by exactly the width of a cut, and thus uniformly raises the peat in prism-like pieces, one after the other, without causing irregularity or waste in the cutting.

In some instances the peat thus obtained is subjected to a mechanical tearing and mixing process, which is usually effected by cylinders or rollers fitted with short blades upon their surfaces, and driven by moderate steam power. The pulp thus obtained is, in some cases, very expeditiously and effectively distributed in pieces upon the drying ground by a mechanical moulding and spreading machine, which is drawn by one workman, while another, walking beside the machine, gives motion to its internal arrangements for delivering the peat in the moulded condition as it travels over the ground.

At the peat works of M. Bocquet, near Mareuil-Sur-l'Ourcq (Oise), two workmen with this machine could effect the moulding and distribution upon the drying ground of from forty to fifty thousand pieces of peat in a full working day.

At these works the costs of producing the dense turf, including its extraction with the "louchet mecanique," as also the mechanical tearing and mixing, the moulding and the drying, may be taken to vary from six to seven or eight shillings per ton. At the works of M. Colart, at Fontaine-Sur-Somme (Somme), where the peat raised with both descriptions of "louchet" was mixed and moulded by hand, the costs of production were, in the year 1872, at about the same rate per ton.

These systems of mixing and moulding are essentially simple, and are worth the attention of any persons who possess peat in such a wet condition, from imperfect drainage, as to be unfit for cutting in the ordinary way.

It will be obvious that the useful applicability of these French implements—the "louchets"—is directed to the extraction of peat in situations where it lies under water.

In some instances the larger implement—the "louchet mecanique"—has been of late improved by the substitution of steam power for hand labour, with increased capabilities of production; but its application is also directed to the raising of submerged peat. It may be said to effect perpendicularly from the edge of a bog with an accompanying waste of water, what the floating scow or barge of Hodges in Canada effects horizontally with its great augurs in front that bore out the peat—but for both water is essential.

In comparison with the Hodges system, the extraction by the "louchet" is, however, much to be preferred, as by it the peat can be won and raised from a depth of fifteen or twenty feet, while in the Hodges arrangement at most only about six feet in depth of the upper portion of the peat

marsh can be extracted, and all beneath that, is left not only waste, but with such a supernatant pond or lake of water over it as to be available hereafter only by natural or artificial drainage. And yet the question is sometimes asked in this country, "Why not adopt the system of Hodges, as is done in Canada?"

The French implement for cutting turf in the ordinary manner, where the bog is freed of water by drainage, is called the "louchet ordinaire," or "petit louchet," to distinguish it from those already mentioned. It is simply the French turf-cutter's slane, with blade from twelve to thirteen inches long by three and a half inches wide, and provided with the usual wing. The labour costs of production of ordinary turf in France, including the stacking and thatching upon the bog, appears to be at the rate of from three shillings and sixpence to four shillings per ton.

It is worth notice that in France, wherever the peat is of such a description as to make it desirable to subject it to a tearing and mixing process, that work is usually done either by manual labour, or by treading under foot, as is done in Holland, or by a simple arrangement of tearing cylinders, requiring only very moderate steam-power, and that the moulding is invariably done by hand, or by a hand-machine, without any application of the pug-mill system with mouth-pieces for the formation of the peat, as in the systems of Schlickeysen, Rahder, and Clayton.

It is obvious that there are advantages in this system of mixing and moulding by hand, where the condition of the peat approximates from excess of water to that of a marsh peat or turf mud deposit, such as are sometimes turned to account for making "hand turf" in this country.

Most of the dense turf produced in France is converted into charcoal for domestic and other uses. When produced from turf made by any system of mixing and moulding peat,

the charcoal is of a firm character, and suited for a variety of useful purposes. In the Autumn of the year 1872, the charcoal made from dense turf of the Ourcq Valley was sold by retail in Paris at about six shillings per cwt. The price of coal from the Charleroy and Mons districts was at the same time in Paris about £2 10*s*. per ton. From three to four tons of dense turf are usually required to make one ton of round marketable charcoal: any fine portions made in the charring or transport are used, in combination with fine wood charcoal and powdered coke, and some tar, for the manufacture of the small artificial fuel known as "Charbon de Paris," and the whole is thus turned to valuable account.

The Drying.

To the air, wind, and sun we must continue to look to get rid of the water which is so largely contained in all peat; and we shall not look in vain if we only commence the cutting of the turf early in the year, not later than the middle or end of March in this country, and avail ourselves of all favourable weather for the drying, up to the termination of the turf-cutting season. There is hardly any industry which can hope for success without being attended with some special laws of its own. It may be inconvenient for us that we cannot postpone the sowing and harvesting of our crops to times that would suit our own purposes better; but we all know only too well that our allotted tasks and duties necessitate our acceptance of the conditions of seasons and of times, and the adaptation of ourselves and of our work to them. Neglect in this respect, however, lies at the root and source of the observation often made amongst us, that our climate is unfavourable to the drying of turf. But it would be much nearer to the truth if we said that our own remissness is unfavourable to our obtaining from our climate the benefits which it brings with it. Either the production of turf is worth

following as an industry, or it is not. If it be, then it should conform to the opportunities of season from the earliest practicable portion of the year, without being left to take its chance of suitable weather, when most of our agricultural works are over. Although few who have had experience in turf-cutting in this country will dispute these conclusions, I shall nevertheless give some particulars of an established industry of this kind in Ireland, with reference to the results that can be effected by its being followed *as a special business*.

Nearly fifty years ago, an extensive tract of undrained bog upon the Shannon, at seven or eight miles distance from Limerick, became the scene of busy labour. From its nearness to the river, and as it did not lie much above the water, it may be said at that time to have had more the character of a marsh than of a firm bog, but this circumstance did not discourage enterprise. A substantial pier for boats was built, and from the Shannon a canal was cut into the morass, and branches were extended through it for drainage and transport. These preliminary works were not executed without meeting with some difficulties, but a day very soon came when they bore fruit, and from two to three hundred persons might afterwards be seen there every season, all employed in the cutting and saving of turf. This undertaking was originated and carried on by the proprietors of a distillery in Limerick, and from it all the fuel they required for their works was obtained and conveyed by water to that city. The turf-cutting work was systematically carried on, and joined with it was the gradual reclamation of the bog itself.

About the year 1842 the distillery works were discontinued by the proprietors, and the bog property passed into the hands of the late Mr. James Macnab, who from the first had conducted its management, and from the year 1842 up to the present the raising of turf for sale to the public, coupled with the reclamation of the bog, has been followed

there *as a special business.* The cutting commences usually in the month of March, and is continued until August, and the quantity made and disposed of in the condition of ordinary cut turf is of late years about five thousand tons annually. The writer examined these works, and he has been assured by their present proprietor, Mr. Alexander A. Macnab, that in no year has unfavourable weather prevented the safe harvesting of the turf; in evidence of which he referred to the fact that, notwithstanding the wetness of the summer and autumn of the year 1872, the quantity of turf cut by him, about five thousand tons, was all saved in good condition, and disposed of to the public a month or two before the end of the year.

A tract of about fifty statute acres of the cut-away bog has been reclaimed into excellent pasturage for cattle, and now realizes a rent of £85 annually, and a further quantity of very nearly forty statute acres is in progress of reclamation. Around the house and offices there are about eighty acres under grass and tillage, with fences interspersed with shrubs and hedge-row trees; and as an illustration in Ireland of the spirit which elsewhere upon a large scale converts morasses into money, and in their place instals the harvest, Mona Lodge,—for so that once old waste by the Shannon is now called,—may be referred to, as well with credit to its energetic owner, as with advantage to all who can take a lesson from such useful industry.

The turf is here for the most part cut and saved at contract prices with the workmen, and it was sold last season at rates equal to about six shillings and sixpence per ton. As this amount included the proprietor's profit and return from the work, we may assume that wherever ordinary turf is produced at present in Ireland, it can be sold with some advantage at the place of production at that rate per ton. With the example of this turf industry on the Shannon before us, let us hope that henceforth many such may be undertaken in this

country, and that in future we may hear, in reference to turf, less about our climate, and something more about our own economy and prudence.

With a view to the more complete drying of turf for use in special works, efforts have of late years been made to effect the drying by artificial heat, but up to the present time they do not appear to have been attended with results that are hopeful for any considerable extension of that principle of drying peat. In its ordinary air-dried condition we have usually in turf from twenty-five to thirty per cent. of water in the state of diffused moisture, and by artificial drying this quantity may be reduced to ten per cent. But if not then or very soon afterwards used, peat thus dried, when exposed to the air, will re-absorb moisture until it contains upon an average from eighteen to twenty per cent. of water, which may be looked upon as the lowest point in respect of water, and the highest point in respect of dryness, to which either dense turf or ordinary turf, in their best air-dried condition, are capable of being brought in the open air, but which in practice is not always attained.

It is unnecessary to observe that the effective heating power of all turf must depend largely upon its state of dryness, but I may be allowed to refer to it as an element in the comparative tests of turf which is not always attended to. It sometimes happens that an evaporative power is claimed for manufactured turf, greater than that of ordinary turf, weight for weight, but the essential conditions of their being both not only of the same quality of peat, but both in the same state of dryness, are not always stated. But it has been ascertained that a difference of fifteen per cent. of moisture will affect the heating results to the extent of *nearly one-half*. That a given weight of dense turf as made by manufacture will, in a smaller space evaporate water more rapidly than the other, may be conceded as the natural result of its

density : but we should expect the same weight of ordinary turf of the same quality and in the same state of dryness, although less dense than the former, to evaporate an equal quantity of water under the same conditions, although not in the same space of time. If this be not so, then we have to ask ourselves by what means has the mere increase of density become in itself a source of additional actual heat, in addition to the quantity already contained in the fuel, the weights and all other conditions, except that of density alone, being the same in both.

Let me trust to the reader's indulgence for thus dwelling upon the comparative values of manufactured and unmanufactured turf; but I do so, believing that, of all others, a full and plain conception of this part of the subject, free from technicalities, is essential to a satisfactory comprehension of the peat question in connexion with improved peat-fuel manufacture.

It will therefore be obvious that the special value of every such system of manufacture is more for industries requiring intensity of heat, than for general domestic purposes. For the former, that value is a high and an all-important one, where the peat itself is not naturally of a sufficiently dense description; but for all ordinary purposes we may in this country be content to look largely to plain cut turf, if we only make efforts for its increased production and better harvesting, until by degrees improved systems, moderately and judiciously introduced at first, shall add their results to already existing resources.

Technical Works.

In the year 1860, a movement was set on foot in Prussia for the investigation of the peat question for public objects, and the late Dr. Dullo was appointed Commissioner for the carrying out of these investigations in the fullest manner, at the

expense of the State. He extended his travels beyond Germany, and in the course of his inquiries, visited Switzerland, France, and Holland, as also Great Britain and Ireland. The results of his examination of the subject were presented in a Report to the Prussian Ministerial Department for Agriculture, and a copy was published in Berlin in the year 1861, by Gustav Bosselmann. This work is entitled "Torf-Verwerthungen In Europa," and it may be said to be the most practical and complete publication upon the treatment of peat, for its improved utilization, that ever came from the press. The whole subject is treated of under the following heads:—The production of turf by machinery,—the production of oils and paraffin from turf,—the employment of turf for iron-making processes; and lastly, the reclamation and cultivation of peat-bogs into arable land in east and west Friesland.

No English translation of this Report appears to have been published, which is to be regretted, as it may be said to summarize, in the most efficient manner, the entire subject up to that date, with a treatment of principles and details of much value for practical purposes. And indeed, when we mention the methods examined and reported on by Dr. Dullo, we shall find that the progress has been very little from the year 1860 up to the present time. The work consists of 113 pages, of which the first 64 pages are devoted to the examination of the systems of Challeton, in France, and of Weber and Exter in Bavaria, together with some others of minor importance; and practically at the present day all that we have before us in the shape of principles of peat fuel systems are comprised in the three now mentioned. The only progress has been in mechanical improvements and modifications,—but in principles of manufacture, none whatever of any practical value.

To the course adopted in Prussia, and to the labours of

Dr. Dullo, the writer takes this opportunity of acknowledging his indebtedness for the public suggestions and recommendations which were made by him in the course of the past year, for the investigation of the modern position of the peat question in other countries, as the first step to be taken before venturing upon patent schemes in peat in Ireland, so as to avoid disasters at the hands of theorists and speculators. In addition to the attention and investigation of the subject of peat-fuel manufacture, both as to values and capabilities, that have since been elicited, the inquiries that were made may be of some service in defining the present position of the peat question for those who may hereafter attempt the improvement of turf manufacture in this country or elsewhere.

In the year 1861 a treatise was published by Challeton, (Paris, E. Lacroix) entitled, "De La Tourbe," in appearance a volume of considerable pretension, but of little practical value. Although extending to 480 pages, the descriptive details of Challeton's own system are exceedingly meagre, while there is much in its unqualified praise. We notice it here merely as the author represents a system; but the nationalities of France and Prussia are not more diverse in character than are the works of Challeton and of Dullo for practical purposes.

The importance of the subject for America, in connexion with the increasing prices of coal and wood, soon led to the introduction of some mechanical systems for turf making in the United States; and as a hand-book upon the subject for the use of those who might embark in peat, Professor S. W. Johnson, of Yale College, in the year 1866 issued a very useful volume, entitled, "Peat and Its Uses" (New York, O. Judd and Company), the objects and value of which may be gathered with advantage from his introductory remarks, some of which are significant enough for ourselves to warrant their being introduced here.

After referring to the adventurous character of American enterprise, as favourable to the development and improvement of machinery for peat, Professor Johnson writes:—"As has always been the case, we shall waste a vast deal of time and money in contriving machines that violate every principle of mechanism and of economy; but the results of European invention furnish a safe basis from which to set out, and we have amongst us the genius and patience that shall work out the perfect method.

"It may well be urged that a good degree of caution is advisable in entering upon the peat enterprise. In this country (America) we have exhaustless mines of the best coal, which can be afforded at a very low rate, with which other fuel must compete. In Germany, where the best methods of working peat have originated, fuel is more costly than here; and a universal and intense economy there prevails, of which we, as a people, have no conception.

"If, as the Germans themselves admit, the peat question there is still a nice one as regards the test of dollars and cents, it is obvious that, for a time, we must 'HASTEN SLOWLY.' It is circumstances that make peat, and gold as well, remunerative or otherwise; and these must be well considered in each individual case. Peat is the name for a material that varies extremely in its quality, and this quality should be investigated carefully before going to work upon general deductions."

This work consists of three parts; the first deals with the origin, varieties, and chemical characters of peat; the second is devoted to its uses in agriculture, and the third treats of peat as fuel. This latter portion of the work comprises about 76 pages, and is a careful compilation, from the best sources at the author's command, of the several systems then in use in Europe, and of some American mechanism at that time designed for making dense turf. For a general review

of the subject up to the year 1866, as collected by the author from various sources, but without the advantage of personal examination, this work may be usefully referred to; and in addition it contains much information from the author's own professional study and analysis of the question; from amongst which we take the following extracts, which will be found useful:—

"It is asserted by some, that, because peat can be condensed so as to approach anthracite coal in specific gravity, it must, in the same ratio, approach the latter in heating power. Its effective heating power is, indeed, considerably augmented by condensation, but no mechanical treatment can increase its percentage of carbon, or otherwise alter its chemical composition; hence it must for ever remain inferior to anthracite."

In support of this position the author gives the following comparative analysis of hard wood, dense turf (called by the author condensed peat), and anthracite coal, which are subjoined for the benefit of those who may not have Professor Johnson's work at hand for reference.

In 100 parts.	Carbon.	Hydrogen.	Oxygen & Nitrogen.	Ash.	Water.	Specific Gravity.
Hard Wood,	39.6	4.8	34.8	0.8	20.0	0.75
Condensed Peat,	47.2	4.9	22.9	5.0	20.0	1.20
Anthracite Coal,	91.3	2.9	2.8	3.0	———	1.40

"In combustion in ordinary fires, the *water* of the fuel is a source of waste, since it consumes heat in acquiring the state of vapour. This is well seen in the comparison of the same kind of peat in different states of dryness. Thus Weber's condensed peat (artificially dried), containing 10 per cent. of moisture surpasses in heating effect that containing 25 per cent. of moisture by nearly one-half," or as 1.48 to 1.0.

"The *oxygen* is a source of waste, for heat as developed from fuel is chiefly a result of the chemical union of atmospheric or free oxygen, with the carbon and hydrogen of the combustible. The oxygen of the fuel being already combined with carbon and hydrogen, not only cannot itself contribute to the generation of heat, but it neutralizes the heating effect of those portions of the carbon and hydrogen of the fuel with which it remains in combination.

"*Nitrogen* and ash are practically indifferent in the burning process, and simply impair the heating value of fuel in as far as they occupy space in it, and make a portion of its weight, to the exclusion of combustible matter.

"Again, as regards density, peat is, in general, considerably inferior to anthracite. The best uncondensed peat has a specific gravity of 0.90; condensed peat usually does not exceed 1.1."

The objects attained by the condensation of peat are very plainly given in a few words by Professor Johnson, as "the bringing of more fuel into a given space, thus making it capable of giving out an intenser heat; at the same time increasing its hardness and toughness, and rendering it easier and more economical of transportation."

This work has the advantage of being illustrated with engravings of some of the principal machines referred to, and the chapters on the agricultural uses of peat form an additional source of useful interest; in all respects, as far as it extends, an honest and useful text-book on peat.

In the year 1867 Mr. T. H. Leavitt of Boston, United States, issued a volume entitled "Facts About Peat" (Boston: Lee and Shepard). The author is known as the inventor of a machine for making dense turf, of which a general description is given in this work. Although extending to 285 pages, the information contained is of a very diffuse and general nature, and without much directly practical value. We could heartily

wish, however, to find the following statement by Mr. Leavitt more fully verified amongst us. In reference to Ireland, we read: "Not only is peat the common fuel of the poor in the interior—and indeed of all classes in some districts—but it is transported in barges, *in immense quantities*, by canal, to Dublin, and there consumed by the wealthier classes of the people."

Let us hope that when the next edition of Mr. Leavitt's "Facts About Peat" shall be published, we may find the consumption of turf in Ireland and in Dublin more in harmony with the views which that gentleman has taken of it, than, unfortunately, can be pretended to at present.

To M. Ernest Bosc we are indebted for one of the latest treatises upon peat, entitled "Traité Complet De La Tourbe" (Paris, Libraire Polytechnique de J. Baudry, 1870). This work is useful as serving to show the present condition of turf industry in France. Its special object, however, appears to be to demonstrate the value of producing moulded peat upon Challeton's principle, but with some improvements in the mechanical arrangements. As any modification of the system of Challeton is of some interest at present, from its connexion with the method of Mr. Box, I shall offer the following detailed particulars from this work of M. Bosc:—

"In the works at Montauger, near Corbeil, M. Challeton has introduced the same system as that which we are now about to describe, but with some improvements made to it.

"The peat, extracted by dredging, is conveyed to the works by canals that run through the bog. It comes in boats to a large collecting basin, the bottom of which slopes towards the centre, which admits of the more convenient raising of the peat by an elevator. This elevator lifts the peat to the upper part of an apparatus composed of a system of cylinders, four feet three inches in length, armed with knives. These cylinders have different diameters; they are

worked by steam power and revolve at a high speed. They tear up the peat, after which it is ground in a conical-shaped mill. Into this mill there flows a quantity of water sufficient to largely dilute the peat. Between the cylinders and the mill a sieve collects the larger fibres (les filaments grossiers) and they are swept aside by a brush upon a wheel, which keeps the sieve clean. The peat, reduced to a very fine fluid pulp (reduite en bouillie tres-fine), flows off into collecting basins in which a shaft provided with arms stirs and mixes the liquid. Heavy matters settle to the bottom, and the thin pulp is by means of an elevator raised and run into a main "conduit" which distributes it into numerous filtering basins, of great superficial extent, but not more than two feet deep, so that the deposit after drying has only about the thickness of a brick. The filters of these basins are made of osier hurdles with mats laid over them. From time to time the bottoms of the basins are cleaned up, so as to get rid of the earthy sediment that collects there. At the end of five or six days, after most of the water contained in the basin has drained away, there is left a residue of pulp (un produit feutré) sufficiently firm for cutting. A cutting tool then divides it into fifty bricks at a time. These bricks are dried on the ground in the ordinary manner without any compression, and they are put together when a little underdried (un peu en vert)."

It will hardly escape notice that one of the objects aimed at from the first in the Challeton system, as well as in the arrangement of it now described, is an attempt to effect the separation, as far as practicable, of earthy substances from peat in which they are found to exist. But it is obvious that no necessity exists for any such manipulation in peat which is practically free from such admixture. In marsh peats earthy and sandy substances more or less abound, a condition natural to their sedimentary deposition and accumulation;

but nothing of the kind, to any thing like the same extent, characterizes our high or red bogs, which do not appear to have been subjected to inundations from time to time, bringing with them more or less alluvial deposits, such as are found in the low marsh peats of France.

The lessons to be derived from the varying characters and natures of peat deposits—and the field of difference is a wide one—are unfortunately not always studied to advantage. In France this process of freeing marsh peat from its sedimentary impurities is termed "epuration," but it is, plainly, one which is not called for in Ireland. The writer saw marsh peat extracted in France by the "louchet mecanique," in the middle part of which, as it emerged from the water, some portions were so foul, from intermixture of sand and earthy deposits, that for a thickness of three feet or more they were cut out from the "louchet" as worthless, and thrown back into the water.

M. Bosc describes the preparation of moulded turf, not subjected to the mechanical system described for its purification—"moulée non epurée,"—and he states that from the 15th of April to the beginning of September a working party, called "une bricolle" can make from one million to a million and a half of moulded turf bricks. The working party consists of one man to raise the peat, two persons to mix and work it into pulp, and four persons to mould it by hand, in all seven labourers.

"The turf, according to temperature, is more or less long in the drying, but upon an average twelve days are required before it can be handled; after twelve days more it is ranged in little piles of ten bricks laid crossways over one another. In fifteen days afterwards these small piles are unmade, in order to be re-made, with the upper pieces placed below, and the lower ones upon top; and in some days afterwards, they are placed together, and covered with reeds or straw."

The cost of this moulded turf is stated, by M. Bosc, to be as follows, per pile of 20,000 bricks.

Extraction, mixing and moulding of 20,000 turf bricks, at contract rate of 1*s.* 8*d.* per 1000, . .	£1	13	4
Heaping into pile, ...	0	2	6
Cover or thatch, ...	0	3	4
General expenses, &c., ...	0	13	4
	£2	12	6

The weight of each pile is stated to be about six tons. According to the figures given we find the cost of this moulded turf to be from eight to nine shillings per ton.

In addition to the practical matters shortly treated of in this volume, there are some chapters of introductory writing, and some on the making of charcoal from turf, &c.

As it is to Germany that we owe most of the efforts that have been made of late years for improved turf manufacture, its history and progress since the year 1860 will be best found in several occasional articles—many of them essentially practical and by able hands—in German serial technical publications, of which the contributions and selections in some of the parts or volumes of "Dingler's Polytechnisches Journal," and in the pages of the "Polytechnisches Centralblaat" may be consulted with most advantage.

For an interesting and detailed account of the system of Hodges in Canada, the reader is referred to three articles upon the subject, illustrated with engravings, in Nos. 342, 344 and 347 of "Engineering" for the year 1872; and for some particulars as to the French implements, the "louchets," to a report by Professor O'Reilly, of the College of Science, Dublin, published also in 1872.

Since the foregoing pages were written, a communication appeared in the columns of "Engineering" for the 18th of April, 1873, from Mr. F. Hahn Danchell, in reference to the claims from time to time made on behalf of mechanical systems for the solution of the peat question. Mr. Danchell's lengthened practice and experience in peat are so well known, as to render it unnecessary for the writer to offer any comment on the value of any contribution to the subject by that gentleman. With his permission we here give the chief portions of Mr. Danchell's communication, premising that it is in the nature of an examination of the results of the peat machine of Messrs. Clayton, of London, of which a notice had appeared in the pages of "Engineering."

Addressing the editor of that journal on the subject, Mr. Danchell writes as follows :—"It is astonishing that after all the attempts that have been made to convert peat profitably into fuel, the experience should have been so entirely lost as to render it possible to bring forward a machine which is said to have solved the difficulty all at once. If it were only required to break up the fibre of the peat, or to macerate it, or reduce it to pulp, and then press the material through an orifice of any given shape, the business would be simple enough. The vertical pug-mill would answer the purpose ; and indeed it has been so used, over and over again. Leavitt, of Boston, and Schlickeysen, of Berlin, among others, constructed machines, and so dealt with peat years ago. Weber in Bavaria has done so likewise with horizontal machines ; and in fact any sausage machine of large size will mince and deliver peat with as much or more ease than meat, inasmuch as peat is a more tender material. I have myself constructed a machine which thus disposes of peat perfectly, and without liability to get out of order from the wood and small stones which are met with in bogs. It is not, therefore, any mechanism that is likely to convert crude peat into high-class

fuel. Those who purchase machines with any such expectation are certain to find themselves deceived. They may see a machine at work on the premises of a machine-maker, and may take his word for the value of peat as fuel compared with coal, as to the amount of moisture it contains, and the time it takes for drying; but they are not told that peat is a widely variable substance; that what is true of one specimen is not true of another, and that it is of different qualities in different parts and depths of the same bog; nor of the facility with which it may be dug in one district, and the difficulty in another. They buy a machine, and when they get it to their own bog and set it to work, they quickly discover their mistake, and begin to rail at those enthusiastic inventors whose acquaintance with peat has been limited to the fact that it is soft, spongy, vegetable matter which when dry will burn.

"With your permission, it may not be out of place to make a few remarks on the true character of peat, and so prevent gentlemen who witness a wonderful mechanism from supposing it capable of effecting any sort of radical transformation, and lending their names to an advertisement which can only issue in disappointment.

"And first I may observe that the statement as to the amount of water requires revision. In the article in 'Engineering' on Clayton's machine it is said to be from 60 to 75 per cent. Now I happened to receive a sample of the peat, whereof thirty tons were sent from Huddersfield to London for treatment—sent by the same gentleman at the same time for analysis. It contained 89 per cent. of water, instead of 60 to 75 per cent., which makes the following difference:—In the case of 60 per cent. of water, there remains 40 per cent. of dry peat, or in the case of 75 per cent. there remains 25 per cent. But air-dried peat contains generally about 25 per cent. of water, so this added to each figure gives, in the

first instance about 53 tons, and in the second 33 tons. Inasmuch, however, as the true proportion of water is 89 per cent., it follows that only 11 tons of perfectly dry peat remain, or rather less than 15 tons of air-dried peat, which, as said, retains 25 per cent. of water. Nor was the sample an exceptionally wet peat, but on the contrary it exhibited a fair average of the moisture contained in peat. But it cannot be doubted that a producer of peat fuel would be greatly disappointed when he discovered that *instead* of 33 tons he got not quite 15 tons, and that for that quantity he paid at the rate of 33 tons, and minus perhaps the royalty due to the inventor of the machine."

Mr. Danchell next refers to the statement made by Messrs. Clayton that their machine will dispose of from 60 to 100 tons of crude peat daily, and he selects the estimate of 60 tons as the safer one, and then deals with it upon the estimate of 5*s*. per ton for cost of production, as put forward by the makers. Owing, however, to the reduced quantity of air-dried peat which is yielded by 60 tons of crude peat with 89 per cent. of water, Mr. Danchell shows that the costs of production would be as much as 11*s*. per ton, inasmuch as the costs would be in all respects the same as would be incurred for peat with 75 per cent. of water as estimated for by Messrs. Clayton—since it is not the dry peat which gives the trouble, but the conversion of the crude material into wet peat bricks. In other words, Mr. Danchell takes the amount which Messrs. Clayton give for costs of air-dried dense turf made by their machine, upon an assumed percentage of 25 per cent. of water in peat, and he shows that the manipulation of peat with 89 per cent. of water must cost a like amount; but as the net result in air-dried peat is in the latter case *less than one-half* the tonnage of the former, its cost becomes proportionately increased. In addition to this high rate of cost, there would be also the inventor's royalty of

1s. per ton, and the manufacturer's profit to be provided for.

"Another point neglected in the estimates of peat as fuel is, that on an average two tons are no more than equal to one ton of coal. It is sometimes urged that by compression it can be made as dense as coal. No doubt it can, but it is a great mistake to suppose that its calorific value is thereby raised to that of coal. Charcoal and coke are not nearly so dense as coal, and yet they yield a greater number of units of heat. It is not the density of a material, but the carbon and free hydrogen therein, which is the measure of the heat-giving value. The experiments of Dulong have shown that one pound of carbon, combined with the necessary quantity of oxygen, develops 12906 units of heat; and one pound of hydrogen, similarly combined, yields 62535 units; it being understood that the unit of heat is the amount of heat necessary to heat one pound of water, 1° Fahr."

Mr. Danchell then applies this test to peat of average kind, in its natural state of dryness containing .464 carbon, .048 hydrogen, and .248 oxygen, and shows, according to the data ascertained by Dulong, that the result is found to give 7151 units of heat for peat, while averages of seventeen varieties of English, Scotch, and Welsh coals, found to contain, carbon .812, hydrogen .048, oxygen .054, give 13044 units of heat for coal.

"But air-dried peat contains from 25 to 30 per cent. of water; and taking the water at 25 per cent., it is obvious that the evaporation of so much at the expense of the remaining 75 per cent. of fuel involves the deduction of an equivalent in heat-giving units, from the 7151, or,—taking the water at 62° Fahr.,—about 279 units, thus reducing the net available heat-giving units in peat to 6872.

"Therefore, peat compared with coal yields only a little more than half the number of units of heat, at best, because

it is not uncommon to meet with inferior qualities which contain only 30, and even less per cent. of carbon. No doubt, statements are made very freely about peat being as good as coal, and even better, but there is no getting over the fact that peat only contains half as much carbon as coal, and that it is on carbon that the calorific value of a fuel depends. The disadvantage is obvious; not only have we to produce two tons of the one for one ton of the other, but also to transport that quantity from the place of manufacture to that of consumption.

"The time given for the drying of peat also requires correction. Eighteen days, as stated in the article in 'Engineering' on Clayton's machine, is the truth under most favourable circumstances, but these favourable circumstances only occur between the first of May and the end of July; and if there is frequent wet weather, which in this country is not unusual, it will take three or four weeks. In the earlier and later months, drying occupies five or six weeks. If the peat has to be dried under cover a further outlay of capital is required for extra sheds, and for the conveyance of the peat to the extension of sheds there is to be added the increased outlay for labour.

"Again, as to the different qualities of peat. It is spoken of as if it were a uniform substance all over the country, when a little knowledge of facts would prove that it varies according to locality, the age and vegetation of which it is formed, and its weight varies from eight to eighty pounds per cubic foot when dry. How this affects the cost of production may appear from a simple calculation. Most sorts of peat, after maceration, moulding, and drying vary in specific gravity from .50 to 1.00. That is to say, 60 tons of crude peat will in one case yield half the weight of dry peat of another. In fact, it may vary a good deal more, owing to the variety of materials that occur in its composition. In peat there is more or less

earthy admixture. It is met with containing as little as 1.5 per cent., and up to 35 per cent., and even more. It is obvious that if carbon be what yields heat, the more of it a given quantity of peat contains the better; and if it contains one-third of incombustible matter, we have so much less heat, as we have more mineral matter.

"Of these and other matters which bear upon the peat question, nothing is said by the inventors of peat machines, and for obvious reasons, of which ignorance is the most prominent. It is much to be regretted that enterprise is so unscrupulously misdirected."

With such able and independent testimonies as those of Mr. Danchell—the foremost mind and hand upon the subject in the kingdom,—upon the incapability of mechanical systems for the solution of the peat question, on any thing like a generally useful scale, the writer now concludes these Papers. His desire has been to present the subject as a whole to his readers, with the least possible technicality of treatment, that its present position and prospects may be fully and fairly understood upon all hands; and that sounder views may henceforth lead to results in the utilization of peat, which cannot be hoped for from the sensational statements that are so frequently made and circulated in the interests of patentees and their agents, and which in this country cannot but be regretted, as leading to empty expectations, and tending to withdraw attention and efforts from the improvement and extension of ordinary turf industry.

THE END.